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Deferred Tax Assets and Bank Regulatory Capital

Abstract

In this study, I examine three issues: (1) whether the probability of bank failure is increasing in the proportion of regulatory capital composed of deferred tax assets (DTA), (2) whether market participants incorporate the increased failure risk associated with the DTA component of capital into their assessments of credit risk, and (3) whether the rules governing the inclusion of DTA into capital encourage risk-taking behavior. Using a sample of U.S. commercial banks, I find that banks that had a larger proportion of capital composed of DTA at the beginning of the recent recession were more likely to fail during the recession, even after controlling for other determinants of bank failure. Furthermore, using a sample of U.S. bank holding companies, I find that banks with a larger percentage of regulatory capital composed of DTA have lower credit ratings and higher bond spreads, with the effect varying negatively with expected profitability. Finally, I find evidence that poorly capitalized banks increased risk-taking to count more DTA towards capital requirements. These findings contribute to the ongoing debate regarding the inclusion of DTA in regulatory capital, as well as the literatures examining the valuation of DTA and the association between regulatory capital and credit risk.

Keywords: deferred tax assets, regulatory capital, banks, credit risk, bond spreads, credit ratings, bankruptcy, risk-taking

I. INTRODUCTION

This study investigates the credit risk associated with the deferred tax asset ("DTA") component of bank regulatory capital (hereafter "DTA capital"). Banks are required to maintain certain levels of regulatory capital to provide a buffer against losses (Kim and Santomero 1988; Ryan 2007; Baesens and van Gestel 2009). In the United States, banks are permitted to count a portion of their DTA towards regulatory capital requirements. However, the benefits associated with DTA can be realized only when the bank earns taxable income, so when banks experience tax losses the DTA lose value. Since DTA capital loses value precisely when the bank needs capital to offset losses, it represents a potentially fragile buffer against these losses.

Consistent with this line of thinking, there is an ongoing debate regarding the appropriateness of including DTA in the regulatory capital calculation.[1,2] Throughout the recent financial crisis, major media outlets such as the Wall Street Journal and Bloomberg routinely drew attention to banks' DTA positions, noting their large size relative to total assets and portraying them as tenuous contributions towards regulatory capital.[3] A January 28, 2009 Bloomberg article noted that tier 1 capital ratios contain "fluff" and mentioned DTA as a primary culprit, calling it an "airy asset" because its reliance on future profitability (Reilly 2009).

The Basel Committee on Banking Supervision specifically targeted the DTA component of capital as a potential method for improving the ability of regulatory capital to protect banks from losses, as well as the accuracy and timeliness of capital ratios as measures of credit risk. In its December 2009 consultative document entitled "Strengthening the resilience of the banking

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[1] I use DTA to refer to both the singular (a deferred tax asset) and the plural (deferred tax assets).
[2] I use the terms capital and regulatory capital interchangeably.
[3] Wall Street Journal articles on DTA and regulatory capital: "Estimates of Losses on Banks' Tax Assets Rattle Investors", October 30, 2009; "Deutsche Bank's lingering capital conundrum", February 4, 2010; "Tax Assets: Here Today, Gone Tomorrow?", April 10, 2010; "Banks Gain in Rules Debate", July 15, 2010. Bloomberg articles on DTA and regulatory capital: "Citigroup's 'Capital' Was All Casing, No Meat", November 24, 2008; "Citi, BofA Show Investors Can't Bank on Capital", January 28, 2009.

sector", the Basel Committee proposed disallowing all DTA from regulatory capital. In its recommendation, it noted that:

"Undue reliance on these assets is not appropriate for prudential purposes, as they may provide no protection to depositors or governmental deposit insurance funds in insolvency and can be suddenly written off in a period of stress."

At the same time, the banking industry has pushed for greater inclusion of DTA in the regulatory capital calculation. In a September 25, 2009 letter to several regulatory agencies, the American Bankers Association and the Clearing House urged these regulatory agencies to revisit the guidelines limiting the inclusion of DTA in regulatory capital.[4] Their reasoning for revisiting the guidelines was based in part on the banks' increased experience with DTA accounting since SFAS No. 109 was adopted in 1992 (specifically the establishment of valuation allowances) and the notion that regulators should treat banks as going concerns. Given the substantial overhaul of financial regulations underway by both the U.S. government and the Basel Committee, the inclusion of DTA in regulatory capital is likely to come under more scrutiny. However, to date there have been no studies on the DTA component of regulatory capital in the United States. Specifically, while plenty of opinions exist, no one has examined whether DTA capital in fact represents a fragile buffer against losses.

This study attempts to fill this gap in the academic literature and inform the debate regarding DTA capital by examining whether the probability of bank failure is related to the level of DTA capital. The recent financial crisis demonstrated the potential for bank failures to

[4] The letter was sent to the Federal Reserve Board of Governors, the Federal Deposit Insurance Corporation, the Office of Thrift Supervision, and the Office of the Comptroller of the Currency. It can be found online at http://www.aba.com/NR/rdonlyres/DC65CE12-B1C7-11D4-AB4A-00508B95258D/62693/090925DTA.pdf [Accessed March 7, 2012]

affect both the financial sector and the economy as a whole. Regulators are likely to focus their efforts to revamp the bank system on reducing the probability of future bank failures. Capital requirements are intended to regulate banks' ability to absorb losses and thus the probability of insolvency (Kim and Santomero 1988; Ryan 2007; Baesens and van Gestel 2009). Thus, examining whether a component of capital is associated with the likelihood of bank failure is likely to be of interest to regulators.

I examine three questions in this study: (1) whether the probability of bank failure is increasing in the proportion of capital composed of DTA, (2) whether market participants incorporate this increased risk of failure into their assessments of credit risk, and (3) whether the rules governing the inclusion of DTA into capital actually encourage risk-taking behavior.

To test whether the proportion of regulatory capital composed of DTA is positively associated with the probability of bank failure, I employ a sample of large U.S. commercial banks and examine whether the proportion of capital composed of DTA at the beginning of the recent financial crisis is positively associated with the risk of bank failure during the crisis. I find that, even after controlling for other potential determinants of bank failures, the risk of failure during the crisis is increasing in the proportion of capital composed of DTA.

Second, I investigate whether two market participants, credit ratings agencies and bond market investors, incorporate the increased probability of failure associated with DTA capital when assessing credit risk. To test this hypothesis, I use a sample of large U.S. bank holding companies and two measures of credit risk: the Standard & Poor's credit rating and the spread between the yield on the bank's bonds and government securities of similar maturity. I estimate the relation between each credit risk proxy and the proportion of regulatory capital made up of DTA. I find that, even after controlling for the overall level of capital and other previously documented determinants of credit risk, bank holding companies with a higher percentage of regulatory capital composed of DTA have lower credit ratings and higher bond spreads, supporting the notion that market participants understand that banks that rely more heavily on DTA capital have more credit risk. Furthermore, I find that the credit risk associated with DTA capital varies predictably with expected future profitability.

Finally, I examine whether the rules governing the inclusion of DTA into regulatory capital may have incentivized poorly capitalized banks to increase risk-taking (Shackelford et al. 2010; Shackelford et al. 2011). In the United States, some DTA are only allowed to be counted as regulatory capital if they are expected to be realized within the next twelve months.[5] For banks looking to raise capital ratios, including more DTA into capital may have been a low cost alternative to issuing new equity or debt. To include additional DTA into capital, banks would have to convince regulators and auditors that the DTA were likely to be realized in the next twelve months. Banks could accomplish this by making risky investments, since the large expected payoffs that accompany risky investments would provide income against which the DTA could be realized. To test this hypothesis, I examine whether current changes in the amount of DTA included in capital are positively associated with future changes in risk. A positive association would support the notion that banks made risky investments in order to justify including more DTA into capital, and that the outcomes of the increased risk-taking manifested in later periods. Using a sample of U.S. bank holding companies, I find that current increases in the amount of DTA included in capital are positively associated with future changes in equity volatility and nonperforming loans, but only for poorly capitalized banks. These results support the idea that poorly capitalized banks increased risk-taking to boost capital ratios through the inclusion of additional DTA.

[5] This limitation only applies to the DTA that derive their benefits from future taxable income. Additionally, banks are also limited in the total proportion of capital that can be composed of DTA dependent on future taxable income. The rules governing the inclusion of DTA into capital are discussed in detail in Section II.

Overall, my study contributes to the ongoing debate regarding the appropriateness of the inclusion of DTA in tier 1 capital. The evidence in this study is consistent with the position of the Basel Committee, which criticizes the inclusion of DTA in capital based on its inability to satisfy claims against the bank during times of poor performance. However, despite this evidence regulators may have incentives to continue allowing DTA to be counted as capital. When a bank experiences extreme negative returns, the losses erode the bank's capital. However, those losses also create DTA in the form of tax loss carryforwards. If DTA are included in capital, then they provide a boost to capital ratios precisely when the bank needs it most. This is a form of regulatory forbearance; the appearance of high capital ratios allows regulators to forgo intervention and instead wait for the bank's performance to improve.[6] This is not unique to the United States; for example, Skinner (2008) concludes that Japanese regulators simultaneously created DTA accounting and included DTA in the regulatory capital calculation to boost bank capital ratios in the late 1990s. However, my results suggest that rules governing the inclusion of DTA into capital incentivized poorly capitalized banks to increase risk-taking at inopportune times, possibly hindering the ability to recover without regulatory intervention. Accordingly, regulators should carefully re-examine whether the inclusion of DTA into capital and the related guidelines are appropriate.

This study also contributes to the literature on the relation between capital and risk. Most prior studies that examine regulatory capital and credit risk focus on either the total capital ratio or the denominator (Koehn and Santomero 1980; Kim and Santomero 1988; Shrieves and Dahl 1992; Aggarwal and Jacques 2001; Rime 2001). These studies implicitly assume that the components of regulatory capital are homogenous and do not lose value. However, regulatory capital is composed of a variety of assets, including DTA which can lose value when the bank

[6] Regulators may also want to include DTA into capital to encourage timely loan loss recognition, since loan loss provisions (which decrease tier 1 capital) result in the creation of deferred tax assets (which can increase tier 1 capital).

fails to earn positive taxable income. My results suggest that capital components should be considered individually when examining the ability to absorb losses and reduce failure risk. Finally, my study contributes to the literature on the valuation of DTA, which has previously focused on equity investors (Amir et al. 1997; Amir and Sougiannis 1999; Guenther and Sansing 2000; De Waegenaere et al. 2003). I extend this literature by examining how credit market participants value DTA.

The remainder of the paper is organized as follows: Section II reviews the extant literature on the valuation of DTA and the association between regulatory capital and risk. This section also covers institutional details, including the rules that govern the inclusion of DTA in regulatory capital. Section III presents the hypotheses, and Section IV describes the research design. Section V explains the sample selection process and provides descriptive statistics. Section VI discusses the empirical results. Section VII concludes the study.

II. PRIOR LITERATURE AND REGULATORY BACKGROUND

Literature on DTA valuation

Since the adoption of SFAS No. 109 in 1992, researchers have provided mixed predictions as to how market participants view DTA. Amir and Sougiannis (1999) point out that DTA represent future tax benefits and thus should be positively valued (the measurement effect). On the other hand, they also note that DTA may have implications for the perception of the firm as a going concern (the information effect). Specifically, if DTA arise from past operating losses, market participants may perceive the firm to be risky, likely to incur future losses, and potentially unable to realize the future tax benefits from its DTA.

Several studies address the value relevance of DTA for equity market participants. Guenther and Sansing (2000) and De Waegenaere et al. (2003) analytically examine the equity market valuation of DTA and tax loss carryforwards, respectively. Amir et al (1997) use a variant of the Feltham and Ohlson (1995) framework to empirically investigate how DTA are valued by investors, finding evidence of both the measurement and information effects. Amir and Sougiannis (1999) examine how equity analysts and investors incorporate information regarding a specific source of deferred taxes, tax carryforwards, into earnings forecasts and share prices. The authors find evidence supporting both the measurement and information effects. Specifically, they find that analysts consider the earnings of firms with tax carryforwards to be less persistent, consistent with the idea that the presence of tax carryforwards is a signal about the potential for future losses. Furthermore, the authors find that equity investors value the tax loss carryforwards as assets, consistent with the notion that they will provide future tax benefits.

Instead of focusing on equity investors and analysts, I examine how credit market participants, specifically bond market investors and credit rating agencies, value DTA. Also in contrast with these studies, I examine the valuation of the portion of DTA included for regulatory capital purposes.

Literature on regulatory capital and risk

Prior studies have arrived at inconsistent conclusions as to whether changing capital requirements leads to an increase or decrease in a bank's credit risk. Shrieves and Dahl (1992) and Duffie and Singleton (2003) model a bank shareholder's incentives using an options pricing framework (increasing risk raises share values). Here, capital requirements mitigate a bank shareholder's tendency to 'gamble' at low capital levels. The capital requirement forces the bank's shareholder to internalize some of the losses caused by risky investments, which in turn causes the shareholder to lower the risk of his investments and thus the bank's credit risk.

However, several studies show that increasing capital requirements can lead to an increase in credit risk. Koehn and Santomero (1980) analytically demonstrate that the probability of bankruptcy may be increasing the capital requirement, since the bank may respond to increases in the capital level by shifting to riskier assets. A follow up study, Kim and Santomero (1988), notes that the result from Koehn and Santomero (1980) is driven by the assumption that capital requirements do not consider asset risk. They show that the regulatory agency can obtain the desired probability of bankruptcy by requiring an optimal level of capital be held for each asset type, with the optimal level being a function of the asset's risk. These studies are primarily concerned with the association between the overall capital ratio and the denominator (total assets versus risk-weighted assets) and risk.

Empirical studies on the association between regulatory capital and risk generally consider the overall capital ratio rather than components of the numerator (capital). Shrieves and Dahl (1992) document a positive relation between changes in capital and changes in risk, suggesting that higher levels of capital may be associated with increased credit risk. On the other hand, Aggarwal and Jacques (2001) find that the implementation of the Prompt Corrective Action provision of the Federal Deposit Insurance Corporation Improvement Act of 1991, which implemented more stringent capital requirements, caused banks to decrease their level of risk. Consistent with Aggarwal and Jacques (2001), Bologna (2011) finds that banks with higher regulatory capital were less likely to fail during the 2008 financial crisis. Rime (2001) studies the banking industry in Switzerland and documents no relation between changes in capital and changes in risk. My study differs from these studies in that it examines the association between a specific component of regulatory capital and credit risk. Ng and Roychowdhury (2011) also examine a specific component of regulatory capital (loan loss reserves) and demonstrate that banks which included loan loss reserves in tier 2 capital were more likely to fail during the recent financial crisis. However, this study differs in that I examine a component tier 1 capital, whereas Ng and Roychowdhury (2011) examine a component of tier 2 capital. Tier 1 capital components are supposed to provide a stronger buffer against losses than tier 2 components, which is the reason that at least half of total bank capital must be in the form of tier 1 capital. My study contributes to the literature by examining a component of the numerator (capital) rather than the overall ratio or denominator, specifically one that can lose its value during times of distress.

Bank regulation in the United States

This study uses two different types of financial institutions: bank holding companies and commercial banks. The former are regulated by the Federal Reserve, while the latter are regulated by either the Federal Deposit Insurance Corporation (FDIC), Office of the Comptroller of the Currency (OCC), or the Office of Thrift Supervision (OTS). Each regulator's mission includes monitoring bank operations in order to protect the banking system.[7] Specifically, one regulatory objective is to ensure financial institutions have the ability to absorb certain levels of losses. This is accomplished by requiring banks to maintain certain levels of capital. Regulators monitor bank capital levels through quarterly reports. If a financial institution is unable to maintain specified capital levels, the regulator can take actions which can include closing and liquidating the institution.

Capital ratios represent a tool for assessing the soundness of financial institutions (Estrella et al. 2000). The primary measure is the tier 1 capital ratio, which is tier 1 capital divided by total risk-weighted assets. Tier 1 capital is calculated by making a series of adjustments to bank common equity.[8] To arrive at the denominator of the ratio (risk-weighted

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[7] For example, the Federal Reserve System states as one of its responsibilities "supervising and regulating banking institutions to ensure the safety and soundness of the nation's banking and financial system (http://www.federalreserve.gov/generalinfo/faq/faqfrs.htm).

[8] The tier 1 capital calculation on the form FR Y-9C is presented in Appendix A.

assets), a bank multiplies each of its assets by a risk weight. For example, U.S. government bonds generally receive a risk weight of zero, meaning the bank is not required to hold any capital in reserve for government bonds. However, most bank assets receive the maximum risk weight (100 percent). Thus, adding risky assets (such as mortgages or commercial loans) to the bank's balance sheet will require additional capital should the bank desire to maintain the same tier 1 ratio, whereas buying assets with a zero risk weight (such as riskless bonds) does not require any additional capital.

Rules governing inclusion of DTA in regulatory capital

In October 1995, the OCC adopted the criteria that currently govern the inclusion of DTA in capital. Appendix A shows portions of the Form FR Y-9C and accompanying instructions that contain the regulatory capital calculations. The inclusion of DTA into regulatory capital is partially governed by accounting standards. SFAS No. 109 allows firms to record DTA to the extent that they will be realized in future periods, and requires a valuation allowance to be recognized if "on the weight of the available evidence, it is more likely than not that some portion or all of the deferred tax asset will not be realized" (FASB, 1992). A bank reports its gross DTA, gross deferred tax liabilities ("DTL"), and valuation allowance in its financial statements. However, not all of the DTA from the financial statements are allowed as part of regulatory capital. Specifically, banks are only allowed to count part of their DTA that are dependent upon future taxable income.[9] The amount of DTA dependent upon future taxable income allowed in capital is limited to the lesser of: (1) the amount of such DTA the bank expects to recognize within one year of the quarter-end report based on its projection of future

[9] According to the instructions to the Form FR Y-9C, DTA that are dependent upon future taxable income are (a) DTA arising from deductible temporary differences that exceed the amount of taxes previously paid that a bank holding company could recover through loss carrybacks if the bank holding company's temporary differences (both deductible and taxable) fully reverse at the report date and (b) DTA arising from operating loss and tax credit carryforwards.

taxable income, or (2) ten percent of the amount of the bank's adjusted tier 1 capital.[10] Banks generally report either a net DTA or net DTL position and the amount of DTA excluded from the regulatory capital calculation in their regulatory filings.[11,12]

III. HYPOTHESIS DEVELOPMENT

In this study, I test three hypotheses. First, I examine whether banks that have a larger proportion of capital composed of DTA are more likely to fail. I focus on the DTA component of regulatory capital because, unlike other capital components (such as commercial loans or trading assets), DTA lose almost all of their value when the bank does not make a profit since they derive their benefit from future taxable income. As a result, DTA cannot be used to satisfy claims against the bank when it incurs losses. This is the primary argument of regulators: that DTA capital offers "no protection to depositors or governmental deposit insurance funds" in times of poor performance (Basel Committee on Banking Supervision 2009). Therefore, holding the overall capital level and other factors constant, banks that have a greater proportion of their capital composed of DTA should be more likely to fail. Stated in the alternative (see Appendix B for a formal model):

H1: The probability of bank failure is increasing in the proportion of regulatory capital composed of DTA.

[10] Adjusted tier 1 capital is the tier 1 capital amount reported on the Form FR Y-9C plus disallowed DTA, disallowed service assets (mortgage and non-mortgage servicing assets), and purchased credit card relationships (see Appendix A).
[11] Banks can net DTA and DTL across jurisdictions in their regulatory filings, and thus generally only report a net DTA or net DTL position.
[12] Banks do not directly report the amount of DTA included (which is net DTA minus the DTA excluded). This calculation must be made manually. I explain this further in the Section IV. Banks also do not indicate how much of their DTA are dependent on future taxable income, nor do they separate out excluded DTA into amounts excluded due to the expected profitability limitation and amounts excluded because of the ten percent of adjusted tier 1 capital limitation.

If banks that have a greater proportion of capital composed of DTA are more likely to fail, then market participants should incorporate this increased probability of failure when assessing the credit risk of these institutions. Stated in the alternative:

H2a: Market measures of credit risk are increasing in the proportion of regulatory capital composed of DTA.

However, the credit risk attached to the DTA component of regulatory capital should vary predictably with expected future performance. Banks with a higher probability of experiencing future losses have a greater need for capital with which to absorb the losses, and thus the composition of capital is more relevant for these banks. Given two banks with equally large probabilities of experiencing future losses, a bank with a smaller proportion of capital composed of DTA will be able to absorb a larger amount of losses and thus less likely to default than a bank with a greater proportion of capital composed of DTA. Market participants are likely to attach more credit risk to DTA capital in banks that are more likely to experience future losses. Stated in the alternative:

H2b: The credit risk associated with the DTA component of capital is decreasing in the expected future profitability of the bank.

Finally, the rules governing the inclusion of DTA into regulatory capital may have incentivized poorly capitalized banks to increase risk-taking (Shackelford et al. 2010; Shackelford et al. 2011). Banks are only allowed to count DTA towards regulatory capital if the DTA are expected to be realized within the next twelve months. For banks looking to boost capital ratios, including more DTA into capital may have been a low cost alternative to issuing new equity or debt. To include additional DTA into capital, banks would have had to convince regulators and auditors that the DTA were likely to be realized in the next twelve months. Banks could accomplish this by making risky investments, since the larger expected payoffs that accompany riskier investments would provide additional expected income against which the DTA could be realized.[13] On average, increased risk-taking in the current period should manifest in future periods.[14] Thus, I expect that banks that are engaging in increased risk-taking in order to include more DTA into capital will show signs of increased risk in future periods. Furthermore, I expect that only banks with relatively low levels of capital will engage in this strategy. Stated in the alternative:

H3: Current changes in the amount of DTA included in capital are positively associated with future changes in risk, but only for poorly capitalized banks.

There are several reasons why empirically I may not find results allowing me to reject the null for Hypothesis 1. First, one of the primary causes of the recent recession was the housing market crash. Therefore, the dominant factors as to whether banks survived or failed during this period may be (1) location (i.e. were they located in a region that was heavily affected by the decline in the housing market) and (2) reliance on real estate loans. Second, simply having an increased probability of default does not mean that more failures will be observed, especially if the higher credit risk associated with DTA capital is not economically significant.

[13] The addition to tier 1 capital would be the difference between the increase in DTA included in capital because of the new risky investment minus the after-tax effect of the loan loss provision. An example: a bank is looking to replace a $1,000 expiring investment, has $200 in new or existing DTA not included in capital, and faces a 50% tax rate. If the bank invests the $1,000 in an investment with a 20% expected return, it will generate an expected tax liability of $100 thus allowing the bank to include half of the DTA into regulatory capital. As long as the after-tax loan loss provision is less than $100, the new investment will result in an increase in regulatory capital. Furthermore, the addition to capital is increasing in the expected return (and thus riskiness) of the investment.

[14] I examine risk outcomes since it is difficult to directly observe risk-taking behavior.

Likewise, even if there is a positive association between the proportion of capital composed of DTA and the probability of bank failure, there are two reasons I may not find that market participants impound this increased probability of failure in their assessments of credit risk (i.e., fail to reject the null for Hypothesis 2a and/or 2b). First, banking trade groups have argued that regulators should treat banks as going concerns that will earn future taxable income. Credit market participants may view banks in this manner, and thus consider DTA as being similar in quality to other components of regulatory capital. Second, since there are limitations on the extent to which DTA can be included in regulatory capital, the DTA portion of regulatory capital is small in comparison to other components and market participants may not judge it to be a material source of credit risk.

IV. RESEARCH DESIGN

Association between DTA capital and bank failures

Hypothesis 1 suggests that there will be a positive association between the proportion of capital composed of DTA at the onset of the recent recession and the probability of failure during the recession. To test this, I estimate the following Cox proportional hazard model (Cox 1972):

$$\begin{aligned} h(t) = \ & h_0 t \times exp\langle \alpha_1 DTAPercent + \alpha_2 Tier1Ratio + \alpha_3 RealEstateLoans \\ & + \alpha_4 Nonperform + \alpha_5 AssetRisk + \alpha_6 Overhead + \alpha_7 ROA4Qtr \\ & + \alpha_8 DepositLiquidity + \alpha_9 Size + \alpha_{10} West + \varepsilon_t \rangle \qquad (1) \end{aligned}$$

I employ a hazard model because of its superiority in forecasting bankruptcies (Shumway 2001).[15] In this model, $h_0(t)$ represents the baseline hazard rate that is a function of time. Multiplying this baseline rate by the $\exp[X_i B_i]$ allows the hazard rate to depend on the vector of

[15] Despite evidence in Shumway (2001) that hazard models are superior at predicting bankruptcy, logistic models have also been used in predicting bank failures (Kolari et al., 2002). Inferences are similar to those presented if I instead estimate a similar model using logistic regression (results not tabulated).

explanatory variables. In the tables, I report both the coefficients and the hazard ratios, the latter representing the change in the risk of failure attributable to a one-standard deviation change (one-unit change for indicator variables) in the independent variable. Since the National Bureau of Economic Research declared that the recent recession began in December 2007, I measure all independent variables as of December 31, 2007. The dependent variable is the number of days until bank failure. For banks that do not fail during the sample period (January 1, 2008 through June 30, 2010), this equals the number of days in the sample period.

The main independent variable is *DTAPercent*, which is measured as the amount of DTA included in tier 1 capital divided by tier 1 capital. To calculate the amount of DTA included in tier 1 regulatory capital, I take the net DTA reported in the appropriate regulatory form and subtract out the amount of DTA the bank excluded from the regulatory capital calculation. If the resulting amount is negative, I set it equal to zero.[16] I expect that the coefficient on *DTAPercent* will be positive, indicating that an increase in the proportion of capital composed of DTA at the beginning of the recent crisis increased the risk of failure over the period.

For this analysis, I include control variables previously found to be associated with bank failures (Ng and Roychowdhury 2011). *Tier1Ratio* is the bank's tier 1 capital ratio. Since the hypothesis relies on holding constant the overall level of capital and varying only the percentage of capital composed of DTA, it is important to control for the bank's overall level of capital. I also estimate this model replacing *Tier1Ratio* with the bank's total capital and leverage ratios, *TotalRatio* and *LeverageRatio*, respectively. *RealEstateLoans* is the ratio of the bank's real estate loans to total assets. *Nonperform* is the ratio of non-performing loans to total loans. *AssetRisk* is the ratio of the bank's 100 percent risk-weighted assets to total risk-weighted assets. *Overhead* is

[16] The actual ratio of DTA in tier 1 capital to total tier 1 capital is not disclosed in the machine-readable regulatory filing data, and thus I must manually calculate it. However, this ratio is disclosed in the Uniform Bank Performance Reports (UBPR). A manual review of several randomly selected banks confirms that my calculated ratio matches the ratio reported in the UBPR.

the non-interest expense as a percentage of total assets. *ROA4Qtr* is the net income over the past four quarters, scaled by average total assets over the same period. *DepositLiquidity* is the bank's cash and available-for-sale securities as a percentage of total deposits. *Size* is the natural logarithm of total assets. *West* is an indicator variable equal to one if the bank was located in the Region 4 according to the U.S. Census Bureau, and zero otherwise.[17]

I make no prediction regarding the association between bank failures and *Tier1Ratio*. While intuition suggests that bank failures should be negatively related to the bank's regulatory capital, riskier banks may choose to hold more capital. Furthermore, increases in capital requirements could lead banks to shift to riskier assets (Koehn and Santomero 1980). Thus, a higher *Tier1Ratio* could be indicative of greater risk and failure probability. Prior research on this matter is mixed (Shrieves and Dahl 1992; Aggarwal and Jacques 2001; Rime 2001; Bologna 2011). Regardless of the relation between *Tier1Ratio* and credit risk, I expect that the composition of tier 1 capital will still matter. That is, even if risky banks choose to hold more capital, holding a greater proportion of the capital in the form of DTA will make the bank more susceptible to negative shocks and increase its credit risk.

Regarding the rest of the control variables, consistent with prior research and with intuition, I expect bank failures to be positively associated with higher values of *RealEstateLoan*, *Nonperform*, and *AssetRisk* during the recent recession. I expect that banks located in the western United States will be more likely to fail, as it was the area most affected by the recent housing market crash.[18] On the other hand, I expect bank failures to be negatively associated with higher values of *DepositLiquidity*, because holding more cash should allow the bank to satisfy withdrawal requests. I have no prediction regarding the association between bank failures and

[17] Inferences are generally unchanged if the following additional control variables are included: an indicator variable equal to 1 if *ROA4Qtr* is negative and zero otherwise, loan loss provisions, and uninsured deposits (results not tabulated).

[18] In my sample, approximately 16 percent of the banks located in Region 4 failed, compared to 5 percent in Region 2 and 7 percent in Region 3. Region 1 experienced no failures in my sample.

ROA4Qtr and *Overhead*. Generally, being more profitable should lower the probability of failure, which suggests that higher values of *ROA4Qtr* should be associated with a lower probability of failure. However, some of the most profitable banks leading up to the recent financial crisis were hardest hit during the crisis. Higher values of *Overhead* could indicate inefficiencies, which would increase the likelihood of bank failure, while they could also indicate that management is well paid and thus not prone to take on large risks (Bertrand and Mullainathan 2003). Finally, I have no expectation as to the association between *Size* and bank failures. Smaller banks were more likely to fail during the recession, but I choose my sample based on size (discussed below) so size may not be a determinant of failure in my tests.[19]

Association between DTA capital and market assessments of credit risk

Hypothesis 2a predicts that if banks with a greater proportion of capital composed of DTA are more likely to fail, then market participants, specifically credit rating agencies and bond market investors, should impound this information when assessing a bank's credit risk. To test Hypothesis 2a, I estimate the following pooled regressions:

$$Rating_{f,t+1} = \alpha_0 + \alpha_1 DTAPercent_{f,t} + \alpha_2 Tier1Ratio_{f,t} + \alpha_3 Size_{f,t} + \alpha_4 ROAQtr_{f,t} + \alpha_5 Liquidity_{f,t} + \alpha_6 Loans_{f,t} + \alpha_7 Volatility_{f,t} + \alpha_8 Crisis_t + \varepsilon_{f,t} \quad (2)$$

$$Spread_{f,t+1} = \alpha_0 + \alpha_1 DTAPercent_{f,t} + \alpha_2 Tier1Ratio_{f,t} + \alpha_3 Size_{f,t} + \alpha_4 ROAQtr_{f,t} + \alpha_5 Liquidity_{f,t} + \alpha_6 Loans_{f,t} + \alpha_7 Volatility_{f,t} + \alpha_8 Maturity_{f,t} + \alpha_9 Coupon_{f,t} + \alpha_{10} Crisis_t + \varepsilon_{f,t} \quad (3)$$

Rating$_{t+1}$ is the bank's Standard & Poor credit rating for quarter t+1. *Rating* ranges from 1 to 22, where 1 represents the highest rating (AAA) and 22 represents the lowest rating (SD or

[19] Larger banks may have been less likely to fail during the crisis because of the 'too big to fail' approach taken by regulators.

D). $Spread_{t+1}$ is the difference in the yield from the bank's outstanding bonds and a risk-free security of equivalent duration. Thus, higher values of $Rating_{t+1}$ and $Spread_{t+1}$ correspond to higher values of credit risk. Both measures of credit risk are measured in quarter t+1, whereas the independent variables are measured at time t. This is done to ensure that all of the explanatory variables are available to market participants (i.e., rating agencies and bond traders) at time t+1 for purposes of determining the bank's credit risk.

As before, *DTAPercent* is the primary variable of interest and is measured as the amount of DTA included in tier 1 regulatory capital divided by the total amount of tier 1 regulatory capital. A positive α_1 would indicate that the market participant's assessment of credit risk is increasing in the proportion of capital composed of DTA.

I include controls for credit risk used previously in the literature (Anderson et al. 2004; Ashbaugh-Skaife et al. 2006; Chen et al. 2008; Barth et al. 2011). *Tier1Ratio* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. *Liquidity* is the sum of cash and available-for-sale securities scaled by total assets. *Loans* is total loans outstanding scaled by total assets. *Volatility* is the standard deviation of monthly returns over the prior 60 months. *Crisis* is an indicator variable equal to one if the bank-quarter occurs during the recent recession as defined by the NBER (December 2007 through June 2009), and zero otherwise. For the bond spreads regression, I include two additional control variables, *Maturity* and *Coupon*. *Maturity* is the time remaining to maturity (measured in years) and *Coupon* is the bond's annual coupon rate.

In testing the market's assessment of credit risk, it is especially important to control for the past and expected future performance of the bank. Past losses can result in net operating loss carryforwards, a form of DTA that can be counted towards regulatory capital. However, past losses may also increase market participants' perception of credit risk. Failing to control for past and expected future performance could result in the coefficient on DTAPercent picking up the information in DTA regarding these variables. This is the information effect of DTA previously documented in the literature. To control for past performance, I include *ROAQtr*, which is net income in quarter t scaled by total assets. I also use *ROAQtr* to control for the future expected performance of the bank, which relies on the assumption that market participants view the earnings process of the bank as a random walk.

To verify the robustness of my results, I employ alternative definitions of *Tier1Ratio* and *ROAQtr*. In place of *Tier1Ratio*, I use the bank's total capital and leverage ratios, *TotalRatio* and *LeverageRatio*, respectively. In place of *ROAQtr*, I use *ROA4Qtr*, defined as the sum of net income over the previous four quarters over the average total assets during the same period. All ratios are multiplied by 100 to convert them into percentages.[20]

As for the control variables, my predictions follow prior research. I expect that credit risk will be decreasing in *Size*, as larger banks are less risky. I expect that credit risk is decreasing in *ROAQtr* (*ROA4Qtr*) since more profitable banks have experienced less capital erosion and thus are less risky. I predict that a bank's credit risk is decreasing in *Liquid*, as liquid assets can be more easily used to satisfy claims against the bank than illiquid assets. I expect credit risk will be decreasing in *Loans*, as loans represent revenue generating investments. I predict credit risk will be increasing in *Volatility*, as banks with higher volatility are more likely to experience insolvency inducing negative outcomes. I expect that credit risk is positively associated with *Crisis*, as risk was higher during the recent recession. As explained above, I make no prediction regarding the sign on *Tier1Ratio*, consistent with the mixed results from prior research on the association between capital ratios and risk (Shrieves and Dahl 1992; Aggarwal and Jacques

[20] Inferences from estimating equations 2 through 5 are generally unchanged if the following additional control variables are included: log of market value of equity as an alternate measure of size, an indicator variable equal to 1 if ROA4 is negative and zero otherwise, ROA over quarters t-4 to t-7 and ROA over quarters t-8 to t-11, variables from the bank failure analysis (real estate loans, non-performing loans, asset risk, overhead, and deposit liquidity), loan loss provisions, and year fixed effects instead of Crisis. Results are also generally unaffected if the contemporaneous credit rating (spread) is included as an additional control variable in the spread (rating) regressions (results not tabulated).

2001; Rime 2001; Bologna 2011). I predict that *Coupon* is positively associated with bond spreads. Generally bonds with longer maturities have higher spreads, but since a part of my sample occurs during the recent financial crisis (when the yield curve was inverted) I make no prediction for *Maturity*.

Association between DTA capital, market assessments of credit risk, and profitability

Hypothesis 2b suggests that since the composition of bank capital is less relevant for banks that are less likely to experience insolvency-inducing negative outcomes, the increased credit risk associated with DTA capital should be negatively associated with expected future profitability. To test this, I estimate the following pooled regressions:

$$\begin{aligned} Rating_{f,t+1} = {} & \alpha_0 + \alpha_1 DTAPercent_{f,t} + \alpha_2 DTAPercent \times ROA4Qtr_{f,t} + \alpha_3 Tier1Ratio_{f,t} \\ & + \alpha_4 Size_{f,t} + \alpha_5 ROA4Qtr_{f,t} + \alpha_6 Liquidity_{f,t} + \alpha_7 Loans_{f,t} + \alpha_8 Volatility_{f,t} \\ & + \alpha_9 Crisis_t + \varepsilon_{f,t} \end{aligned} \tag{4}$$

$$\begin{aligned} Spread_{f,t+1} = {} & \alpha_0 + \alpha_1 DTAPercent_{f,t} + \alpha_2 DTAPercent \times ROA4Qtr_{f,t} + \alpha_3 Tier1Ratio_{f,t} \\ & + \alpha_4 Size_{f,t} + \alpha_5 ROA4Qtr_{f,t} + \alpha_6 Liquidity_{f,t} + \alpha_7 Loans_{f,t} + \alpha_8 Volatility_{f,t} \\ & + \alpha_9 Maturity_{f,t} + \alpha_{10} Coupon_{f,t} + \alpha_{11} Crisis_t + \varepsilon_{f,t} \end{aligned} \tag{5}$$

All variables are defined as previously discussed. My proxy for expected future profitability is *ROA4Qtr*, which assumes market participants believe the bank's earnings process is approximated by a random walk.[21] Consistent with Hypothesis 2b, I expect α_2 (the coefficient on the interaction of *DTAPercent* and *ROA4Qtr*) to be negative.

[21] Inferences are generally similar if the proxy for expected profitability is an indicator variable equal to 1 if the bank has a ROA4 above the sample median in that quarter and zero otherwise, a variable ranging from zero to one based on which decile the bank's ROA4 is in that quarter, and median/decile variables based on the most recent median analyst earnings forecast for the current fiscal year.

Association between increases in DTA capital and future risk outcomes

Hypothesis 3 suggests that if the rules governing the inclusion of DTA into capital incentivize banks needing capital to increase risk-taking, then a positive association should be observed between current period changes in DTA included into capital and future changes in risk proxies. To test this, I estimate the following pooled regressions:

$$\begin{aligned} \Delta Risk_{f,t+j} = {} & \alpha_0 + \alpha_1 \Delta DTAIncluded_{f,t} + \alpha_2 PoorlyCapitalized_{f,t} \\ & + \alpha_3 \Delta DTAIncluded * PoorlyCapitalized_{f,t} + \alpha_4 \Delta Tier1Ratio_{f,t} + \alpha_5 \Delta Size_{f,t} \\ & + \alpha_6 \Delta ROA\mathrm{Qtr}_{f,t} + \alpha_7 \Delta Liquidity_{f,t} + \alpha_8 \Delta Loans_{f,t} + \alpha_9 Crisis_f + \varepsilon_{f,t} \qquad (6) \end{aligned}$$

The dependent variable is the future change in risk. I employ two proxies for a bank's risk, the change in equity volatility (*ΔVolatility*) and the change in nonperforming loans (*ΔNPL*). *ΔVolatility* is the future period's equity volatility minus the current period's volatility, where volatility is calculated as previously described. *ΔNPL* is calculated as the future period's nonperforming loans minus the current period's nonperforming loans, scaled by current total loans. I measure the change in future risk over three different periods: one quarter, two quarters, and four quarters.

The primary independent variables are *ΔDTAIncluded* and *PoorlyCapitalized*. *ΔDTAIncluded* is defined as the current quarter's DTA included in regulatory capital minus the previous quarter's DTA included in capital, scaled by lagged total assets. *PoorlyCapitalized* is an indicator variable equal to 1 if the bank had a tier 1 ratio in the bottom 30% of all banks at the beginning of the quarter, and zero otherwise. If poorly capitalized banks are making risky investments in order to justify including more DTA into capital during the current period, and if those risky investments manifest in risk outcomes in future periods, then I would expect that *ΔDTAIncluded* will be positively associated with future changes in risk for these banks. Thus I predict a positive coefficient on the interaction term *ΔDTAIncluded*PoorlyCapitalized*. I also expect the sum of the coefficients on *ΔDTAIncluded* and *ΔDTAIncluded*PoorlyCapitalized* to be positive.[22]

V. SAMPLE SELECTION AND DESCRIPTIVE STATISTICS

Sample selection for bank failure tests

I test hypothesis 1 using U.S. commercial banks and thrifts. I examine commercial banks rather than bank holding companies ("BHC") for this hypothesis because commercial banks fail more often than BHC. The FDIC maintains a list of failed commercial banks on its website.

I require commercial banks in my sample to have a minimum of $750 million in total assets to balance my desire to investigate large banks against the need to observe some bank failures.[23] I investigate large banks because (1) DTA capital is more prevalent in large banks, and (2) regulators are likely more concerned with the failure of large banks than small banks.[24,25] I require non-missing data for all regression variables. To mitigate the effect of outliers in my main independent variable, I delete observations in the top 1 percent of DTAPercent (by definition, it is bounded below at zero). Finally, I discard observations with tier 1 capital ratios greater than 200 percent, as these generally represent data errors (i.e., 8 was recorded instead of 0.08).

For the commercial bank sample, all data comes from the Federal Reserve Bank of Chicago.[26] Accounting and regulatory data is measured as of December 31, 2007, and bank

[22] Inferences are generally unaffected if the cut-off for PoorlyCapitalized is the bottom 20% or 40% of banks by tier 1 ratio at the beginning of the quarter.
[23] Results are not sensitive to this choice. For example, inferences are qualitatively similar if the cut-off is between $500 million and $1 billion.
[24] 74 percent of banks with assets greater than $750 million have DTA capital, whereas only 44 percent of banks with less than $750 million in assets have DTA capital.
[25] Two reasons regulators may be concerned with the failure of large banks rather than small banks: (1) the failure of large banks can have ripple effects on the rest of the economy, and (2) liquidating large banks is likely more costly and difficult.
[26] For both the commercial bank and BHC samples, I get quarterly data on DTA from the regulatory filings. As these filings do not break down DTA by type, I cannot estimate separately the effects of different types of DTA.

failures examined occur between January 1, 2008 and June 30, 2010. The final commercial bank sample contains 736 commercial banks and thrifts, 50 of which failed during the sample period.

Sample selection for credit rating, bond spread, and risk-taking tests

To examine hypotheses 2a and 2b, I employ a sample of U.S. bank holding companies because they are more likely to have a credit rating and more likely to issue bonds than commercial banks. For a BHC bank-quarter observation to be included in the sample it must have non-missing data for all independent variables, as well as a non-missing value for $Rating_{t+1}$. For the computation of *Volatility* I require at least 36 months of stock return data. I also eliminate DTAPercent and tier 1 capital ratio outliers as discussed above.

For the BHC sample, I obtain accounting data and S&P credit ratings from the Compustat Quarterly file, bond variables from Datastream, stock returns from the CRSP monthly stock file, analyst forecast data from IBES, and regulatory capital and other accounting data (including quarterly DTA amounts) from the Federal Reserve Bank of Chicago. I start my sample period with the first quarter of 2001 and end with the first quarter of 2010. The BHC dataset comprises of 2,050 (1,002) bank-quarter observations for the credit rating (bond spread) analyses, representing 67 (41) bank holding companies.[27]

To examine hypothesis 3, I employ the sample of BHC used in the credit rating and bond spread tests. To make the sample, bank-quarter observations had to have non-missing data for each dependent and independent variable. This sample contains 1,744 bank-quarter observations representing 67 bank-holding companies.

While publicly traded banks would disclose DTA by type in the tax footnote to the financial statements, they do so in the annually, not quarterly. Furthermore, many commercial banks in my sample are not publicly traded.

[27] The inferences from the credit ratings regressions are unaffected if I restrict those tests to bank-quarters with a non-missing $Spread_{t+1}$ (results not tabulated).

Descriptive statistics

Table 1 provides descriptive statistics and correlations for the samples used in this study.[28] Panel A in Table 1 presents the descriptive statistics for the commercial bank sample. On average, DTA made up 3 percent of tier 1 capital for commercial banks in my sample, and 74 percent of banks were counting some DTA for regulatory capital purposes at the end of 2007. Banks in this sample were on average well capitalized, but some banks were below the minimum threshold for being considered well capitalized (tier 1 capital ratio of six percent). They were also very large, with average total assets of $13.7 billion. Real estate loans made up a large portion of the average bank balance sheet (over 50 percent of total assets). Only 20 percent of the banks were located in the western U.S., but account for almost half of the bank failures. Panel B in Table 1 provides descriptive statistics for the BHC sample. On average, DTA make up 2.4 percent of tier 1 capital, and 55 percent of bank-quarter observations have some DTA included in regulatory capital. Banks in the BHC sample are much larger than those in the commercial bank sample, with the average total assets being $123 billion, and every bank is well-capitalized. The average spread is 222 basis points and the average credit rating is an A-.

[INSERT TABLE 1 HERE]

Panel C contains the correlation matrix for the commercial bank sample. *DTAPercent* is positively correlated with the real estate market variables (*RealEstateLoans*, *Nonperform*, *AssetRisk*, and *West*) and negatively correlated with *Tier1Ratio*, emphasizing the need to control for factors likely to be of first order importance in determining the failure of banks during the recession. Panel D presents the correlation matrix for the BHC sample. DTA capital is correlated negatively correlated with *ROAQtr*. This is probably a result of the operating loss carryforward component of DTA, and reinforces the need to control for bank performance when evaluating

[28] Ratios are generally calculated as percentages, and all continuous variables except for *DTAPercent* and capital ratios are winsorized at 1 percent and 99 percent.

market perception of DTA capital. The two dependent variables, *Spread* and *Rating*, are positively correlated as expected.

In both panels C and D the primary variable of interest, DTAPercent, is consistently correlated with greater credit risk: increased risk of failure, lower credit ratings, and higher bond spreads. Figure 1 provides corroborating evidence: banks that failed or had credit risk measures greater than the sample median had higher percentages of regulatory capital composed of DTA and were more likely to have a large portion (5 percent or greater) of capital composed of DTA than banks that did not fail or were below the sample median on the two credit risk measures.

[INSERT FIGURE 1 HERE]

VI. EMPIRICAL RESULTS

Association between DTA capital and bank failures

Table 2 contains the results of estimating the Cox proportional hazards model given in equation 1.[29] I report both the coefficients (panel A) and the hazard ratios (panel B). Positive coefficients and hazard ratios greater than one indicate that higher values of that variable increased the risk of failure during the recession. Column 1 contains the baseline estimation (equation 1 without *DTAPercent*). The most notable result from column 1 is that failure during the recent recession was driven largely by the housing market. Banks with more real estate loans, higher non-performing loan ratios, and riskier assets had higher failure risks, as did banks located in the western. Additionally, banks with lower capital ratios had higher failure risks (one-tailed p-value of 0.03), consistent with intuition and prior research (Bologna 2011). The ratios on all other control variables are generally consistent with predictions but statistically insignificant.

[INSERT TABLE 2 HERE]

[29] Statistical inferences are made using standard errors clustered by bank and two-tailed tests unless otherwise noted.

Column 2 contains the estimation of equation 1 with only *DTAPercent*. The coefficient on *DTAPercent* is positive and statistically significant (p-value < 0.01). In column 3, I include the other explanatory variables in the hazard model. The coefficient on *DTAPercent* remains positive and statistically significant, with the hazard ratio indicating that a one-standard deviation increase in *DTAPercent* increases the risk of bank failure by approximately 36 percent.[30] By comparison, the economic significance of the real estate variables (*RealEstateLoan*, *Nonperform*, *AssetRisk*, and *West*) and the capital ratio variables is greater. Thus, while the DTA component of capital may not have had a first-order effect on bank failures during the recent crisis, it was still economically meaningful. The results in columns 4 and 5 indicate that the inferences in column 3 are unchanged when replacing *Tier1Ratio* with *TotalRatio* and *LeverageRatio*, respectively. Overall, the results in Table 2 show that banks with a greater proportion of capital composed of DTA had a higher risk of failing during the recent financial crisis.[31]

Association between DTA capital and market assessments of credit risk

Tables 3 and 4 contain the results from estimating equations 2 and 3, which test whether DTA capital is associated with lower credit ratings and greater bond spreads.

Table 3 contains the results from estimating equation 2. Since credit rating is an ordinal variable, I estimate equation 2 using an ordered logistic regression. Column 1 contains a baseline regression that omits *DTAPercent*. As predicted, *Size*, *ROAQtr*, *Liquidity*, and *Loans* have negative and significant coefficients, suggesting banks that are larger, more profitable, more liquid, and have more loans have higher credit ratings. Interestingly, the coefficient *Crisis* is negative, although only occasionally significant, indicating that on average credit ratings were

[30] To calculate hazard ratios, I take the coefficient from the hazard regression and multiply it by the standard deviation for non-indicator variables (by 1 for indicator variables), then take the exponential of the resulting amount.
[31] I also estimate equation 1 within an alternate sample, in which each failed bank is matched to a single non-failed bank that has the closest tier 1 ratio within the same decile of total assets. Inferences are qualitatively similar.

higher during the financial crisis. *Volatility* is positive and significant, meaning that banks with more volatile returns have lower credit ratings. *Tier1Ratio* is negatively associated with credit ratings, indicating that banks with higher tier 1 capital ratios had on average higher credit ratings, although it is not statistically significant.[32]

[INSERT TABLE 4 HERE]

Column 2 contains the results from estimating equation 2 with only *DTAPercent*. The coefficient on *DTAPercent* is positive and highly significant (p-value < 0.01), indicating that banks with a higher percentage of capital composed of DTA have worse credit ratings. Column 3 contains the results from estimating the full model from equation 2. The coefficient on *DTAPercent* remains positive and statistically significant (p-value < 0.01). Coefficients on the control variables are largely similar to those in column 1, except that the negative coefficient on *Tier1Ratio* becomes marginally significant (one-tailed p-value of 0.09). Columns 4, 5, and 6 contain alternative specifications of the equation 2. In column 4, I replace *ROAQtr* with a more backward looking measure, *ROA4Qtr*. In columns 5 and 6, I use the *TotalRatio* and *LeverageRatio* in place of *Tier1Ratio*. In all of these alternative specifications the coefficient on *DTAPercent* remains positive and highly significant (p-value < 0.01 in all three columns). The results in Table 3 are consistent with credit rating agencies considering the increased failure risk associated with DTA capital when setting credit ratings.

Table 4 contains the estimation of equation 3 via OLS. As in Table 3, column 1 contains a baseline model including only control variables. The coefficients on the control variables are generally consistent with expectations, with the exception of *Loans* and *Size* which are only marginally significant. Also somewhat surprising is that *Tier1Ratio* is positive and significant

[32] The relatively weak significance of *Tier1Ratio* in the credit rating regressions appears to be driven by its high correlation with profitability (Spearman correlations of 0.64 with *ROAQtr* and 0.71 with *ROA4Qtr*). When profitability proxies are dropped from the model, the coefficient on *Tier1Ratio* becomes highly significant (p-value < 0.01), while other inferences remain unchanged.

which, while consistent with some prior research indicating that riskier banks maintain higher capital ratios, is inconsistent with the results from the bank failure and credit rating tests.

[INSERT TABLE 3 HERE]

Column 2 contains the results from estimating equation 3 without the control variables. As predicted, *DTAPercent* is positive and highly significant (p-value < 0.01), meaning banks with larger proportions of capital composed of DTA have higher bond spreads. When I include control variables in the regression (column 3), the coefficient on *DTAPercent* remains highly significant. According to column 3, a one-standard deviation increase in *DTAPercent* is associated with an approximately 28 basis point increase in the spread, representing a 12 percent increase over the average spread. Columns 4, 5, and 6 contain alternative specifications of the main regression in column 2. In columns 3 and 4, I use the bank's total ratio and leverage ratio instead of tier 1 ratio. In column 5, I use *ROA4Qtr* instead of *ROAQtr*. The inferences from column 2 are unchanged in these alternative specifications (one-tailed p-values of 0.05, 0.02, and 0.02 in columns 3, 4, and 5, respectively). *DTAPercent* is consistently positive as well as statistically and economically meaningful, indicating that on average banks with greater proportions of capital composed of DTA have higher bond spreads. Taken as a whole, the results in Table 4 suggest that bond market investors impound the increased failure risk associated with DTA capital when assessing credit risk.

Association between DTA capital, market assessments of credit risk, and profitability

The analyses in Table 5 test whether the increased credit risk associated with DTA capital is lessened for banks that are expected to be profitable in the future. As stated before, my measure of expected profitability is *ROA4Qtr*. To test whether an increase in expected profitability decreases the credit risk market participants associate with DTA capital, I test whether the coefficient on the interaction of *DTAPercent* and *ROA4Qtr* is significantly negatively.

[INSERT TABLE 5 HERE]

Columns 1 and 2 contain the results from estimating the reduced and full versions of equation 4 using ordered logistic regression. As in Table 3, the coefficient on *DTAPercent* is positive and significant, and the coefficient on *ROA4Qtr* is negative and significant. However, the coefficient on the interaction term is insignificantly different from zero. Ai and Norton (2003) point out that statistical software packages do not always calculate correct coefficients for interaction effects in non-linear models.[33] The coefficient on the interaction term remains insignificantly different from zero when I re-estimate the reduced and full versions of equation 4 using OLS (columns 3 and 4).[34] Given the problems with both ordered logistic and OLS specifications, I cannot determine whether the insignificant coefficient on the interaction is driven by incorrect econometrics or whether credit ratings agencies do not adjust the credit risk associated with DTA capital for expected profitability.

Columns 5 and 6 contain the results from estimating reduced and full versions of equation 5 using OLS. In column 1, the coefficient on *DTAPercent* is positive and significant (p-value < 0.01) and the coefficient on *ROA4Qtr* is negative and significant (p-value < 0.01), consistent with the results in Table 4. The coefficient on the interaction term *DTAPercent*ROAQtr* is negative and statistically significant (p-value 0.04). The negative coefficient indicates that the increased credit risk associated with DTA capital is partially mitigated for more profitable banks. Column 6 indicates that these results still hold when

[33] This is because calculating a cross-partial with respect to two variables in a non-linear model is not the same as calculating a main effect. Since the software does not know that the variable is an interaction term, it treats it like a main effect, thus calculating an incorrect coefficient.
[34] This approach is not without its own problems. Since the dependent variable is a credit rating which only takes on integer values, this violates two assumptions of OLS: normally distributed errors and homoskedasticity.

including control variables (interaction term p-value of 0.01).[35] Overall, the results in Table 5 provide some evidence that the increased credit risk market participants associate with DTA capital is negatively associated with expected future profitability.

Caveat regarding results from bank failure and market credit risk measures tests

The conclusions reached in the bank failure and market credit risk tests are subject to one important caveat. I interpret my results as holding for all banks, but that need not be the case. For my bank failure tests I employ a sample of U.S. commercial banks, and for my market credit risk tests I use a sample of U.S. bank holding companies. It could be the case that DTA capital is not an economically meaningful factor in the failure probability of bank holding companies, and market participants may not correctly impound the increased failure risk associated with DTA capital when assessing the credit risk of commercial banks. While I believe this to be unlikely, it would be difficult to formally test for reasons previously mentioned: bank holding companies rarely fail, and commercial banks are generally not publicly traded and thus do not have sufficient data on bond spreads or S&P credit ratings.

Association between changes in DTA included and future risk outcomes

Table 6 presents the results from estimating equation 6. Panel A (Panel B) contains the results using the change in equity volatility (change in nonperforming loans) as the risk outcome proxy. I measure the dependent variable over three different time periods: over the next quarter (column 1), over the next two quarters (column 2), and over the next four quarters (column 3).

[35] When including control variables, being above the median of ROA4Qtr is associated with mitigation of approximately 61 percent of the credit risk associated with DTA capital, and moving up one decile in ROA4Qtr is associated with mitigation of approximately 13 percent of the credit risk associated with DTA capital (results not tabulated).

For brevity, I only report the coefficients on the main independent variables (*ΔDTAIncluded*, *PoorlyCapitalized*, and the interaction term).

[INSERT TABLE 6 HERE]

The coefficient on the interaction term is largely consistent with expectations. When change in equity volatility is the risk proxy, the interaction term coefficient is positive and significant over all three time periods. When using change in nonperforming loans as the proxy for risk, the coefficient on the interaction term is positive for all three time periods and is statistically significant when the change is measured over the next two or four quarters. Furthermore, the sum of the coefficients on *ΔDTAIncluded* and the interaction term is positive in all six specifications (statistically significant in five of the six models), indicating that current changes in DTA included in capital are associated with increased future changes in risk only for poorly capitalized banks. Overall, the results are consistent with my hypothesis that banks with relatively poorer capital ratios took on riskier investments in the current period to justify counting more DTA in capital, and consequently displayed increases in risk in future periods.

VII. CONCLUSION

In this study, I find that proportion of regulatory capital composed of DTA is positively associated with the risk of bank failure. Furthermore, market participants appear to incorporate the increased risk of failure associated with the DTA component of capital when assessing bank credit risk. Finally, I find that the rules governing the inclusion of DTA into regulatory capital seem to have incentivized poorly capitalized banks to engage in increased risk-taking.

Overall, my results are consistent with the position of the Basel Committee that DTA capital does not provide an adequate buffer against losses. Furthermore, the rules governing the inclusion of DTA into regulatory capital may hamper regulators' ability to practice forbearance.

This study also contributes to two literatures. First, this study extends the DTA valuation literature by examining the valuation of DTA by credit market participants. Finally, this paper contributes to the literature examining the association between regulatory capital and credit risk by being the first to investigate the association between credit risk and a specific component of tier 1 capital. Future research could consider whether other components of tier 1 capital, such as goodwill, have similar effects on bank failures, credit risk measures, and risk-taking behavior.

APPENDIX A – REGULATORY CAPITAL CALCULATION FROM FORM FR Y-9C

Schedule HC-R—Regulatory Capital

This schedule is to be submitted on a consolidated basis.

For Federal Reserve Bank Use Only

C.I.

FR Y–9C
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Dollar Amounts in Thousands	BHCX	Bil	Mil	Thou	
Tier 1 capital					
1. Total bank holding company equity capital (from Schedule HC, item 27.a)	3210				1.
2. LESS: Net unrealized gains (losses) on available-for-sale securities[1] (if a gain, report as a positive value; if a loss, report as a negative value)	BHCK 8434				2.
3. LESS: Net unrealized loss on available-for-sale equity securities[1] (report loss as a positive value)	A221				3.
4. LESS: Accumulated net gains (losses) on cash flow hedges[1] (if a gain, report as a positive value; if a loss, report as a negative value)	4336				4.
5. LESS: Nonqualifying perpetual preferred stock	B588				5.
6. a. Qualifying Class A noncontrolling (minority) interests in consolidated subsidiaries	G214				6.a.
b. Qualifying restricted core capital elements (other than cumulative perpetual preferred stock)[2]	G215				6.b.
c. Qualifying mandatory convertible preferred securities of internationally active bank holding companies	G216				6.c.
7. a. LESS: Disallowed goodwill and other disallowed intangible assets	B590				7.a.
b. LESS: Cumulative change in fair value of all financial liabilities accounted for under a fair value option that is included in retained earnings and is attributable to changes in the bank holding company's own creditworthiness (if a net gain, report as a positive value; if a net loss, report as a negative value)	F264				7.b.
8. Subtotal (sum of items 1, 6.a., 6.b., and 6.c., less items 2, 3, 4, 5, 7.a, and 7.b)	C227				8.
9. a. LESS: Disallowed servicing assets and purchased credit card relationships	B591				9.a.
b. LESS: Disallowed deferred tax assets	5610				9.b.
10. Other additions to (deductions from) Tier 1 capital	B592				10.
11. Tier 1 capital (sum of items 8 and 10, less items 9.a and 9.b)	8274				11.

Disallowed Deferred Tax Assets Calculation

(a) Enter the amount from Schedule HC-R, item 8 .... ______

(b) Enter 10% of the amount in (a) above ..... ______

(c) Enter the amount of deferred tax assets reported in Schedule HC-F, item 2 .... ______

(d) Enter the amount of taxes previously paid that the bank holding company could recover through loss carrybacks if the bank holding company's temporary differences (both deductible and taxable) fully reverse at the report date .... ______

(e) Amount of deferred tax assets that is dependent upon future taxable income: subtract (d) from (c); enter -0- if the result is a negative amount .... ______

(f) Enter the portion of (e) that the bank holding company could realize within the next 12 months based on its projected future taxable income. Future taxable income should not include net operating loss carryforwards to be used during the next 12 months or existing temporary differences that are expected to reverse over the next 12 months .... ______

(g) Enter the lesser of (b) and (f) .... ______

(h) Disallowed net deferred tax assets: subtract (g) from (e); enter 0 if the result is a negative amount .... ______

APPENDIX B – MODEL

Baseline example

To formally model my hypothesis, I borrow from the model in Shin (2010) of one bank and two available assets: a risky security and a risk-less security (cash). Following Shin's notation, let the price of the risky security at time t be p_t and the amount of the risky security held by the bank be y_t. The bank's cash holding is represented by c_t. The future (uncertain) price of the risky security is given by p_{t+1}. Let $\tilde{r}_{t+1}$ denote the return from time t to t+1 on the risky security, distributed with mean μ and variance σ^2. Thus, the bank's holding of the risky security at time t+1 is equal to (1+$\tilde{r}_{t+1}$) $p_t y_t$. The return is not necessarily independently distributed; there can be times where positive or negative returns are more likely. Finally, let the return on the risk-less asset be normalized to zero and the bank's capital at time t be represented by e_t.

The bank is not limited to holding positive quantities of both the risky and risk-less assets. Specifically, it is able to borrow the risk-less asset and use the proceeds to purchase additional units of the risky security. Assume for the time being that the interest rate on such borrowing is equal to zero. At time t the asset side of the bank's balance sheet is composed of cash and securities held, and the liability side contains the initial contributed equity. That is, the following identity holds at date t: $y_t p_t + c_t = e_t$, where a positive (negative) y_t represents a long (short) position in the risky asset and a positive (negative) c_t represents cash holdings (debt).

At time t, the bank decides its holdings of the risky and risk-less securities. At time t+1, a return $\tilde{r}_{t+1}$ is randomly selected, and the bank's balance sheet changes accordingly. Specifically, the new value of equity is given by e_{t+1} = y_t p_{t+1} + c_t or, expressed another way,

$$e_{t+1} = \tilde{r}_{t+1}\, y_t\, p_t + e_t \qquad (7)$$

If the next period equity drops to zero or below (i.e., if $e_{t+1} \leq 0$) then the bank becomes insolvent. This happens if the return is sufficiently bad such that the following condition holds:[36]

$$\tilde{r}_{t+1} \leq -\frac{e_t}{p_t y_t} \tag{8}$$

The probability of insolvency is depicted in figure 1.

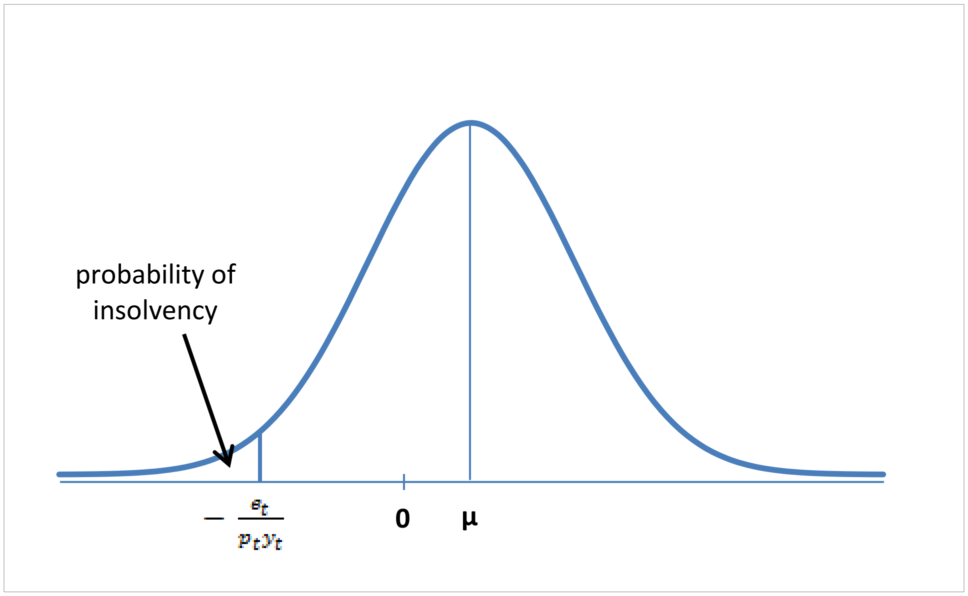

Figure 1: Insolvency probability

Note that a requirement to hold a certain amount of capital is similar to requiring a certain level of initial equity (e_t). The purpose of such a requirement is to minimize the probability of insolvency. This is readily apparent in equation 8 and figure 1 above – the greater the amount of initial equity, the less likely that the next period return will be sufficiently bad enough to result in the failure of the bank. As mentioned before, this is one of the main purposes of regulatory capital – to reduce the likelihood of insolvency.

Example with DTA capital

[36] Note that this condition assumes that the bank takes a long position in the risky asset. Otherwise, the insolvency condition would be the same but with $-\tilde{r}_{t+1}$ instead of $\tilde{r}_{t+1}$. Given that most banks do not hold short positions in loans and other risky investments, I think this assumption is descriptive of reality.

To this point, I have not made any statements regarding the composition of equity. Now assume that equity can be composed of two things: (1) contributed capital (CC), which can be thought of as cash and (2) deferred tax assets (DTA). These two types of equity differ only in what states of the world they are able to satisfy claims against the bank. Specifically, in this example, the primary claim against the bank is offsetting losses suffered by the holdings in the risky asset. The important characteristic of contributed capital is that its ability to absorb losses is not dependent on the future state of the world (i.e. the realization of $\tilde{r}_{t+1}$). The benefits that accompany DTA, on the other hand, are only realized when $\tilde{r}_{t+1} > 0$. These assumptions are not implausible: cash, for example, can be used to satisfy claims against the bank regardless of the bank's performance, while DTA only result in tax savings (less cash taxes paid) when there is positive taxable income. Already, it should be clear that DTA capital is unable to absorb losses incurred by the risky asset holdings, since it can only satisfy claims against the bank when performance is good.

In this next example, there are two banks, Bank A and Bank B. Bank A's equity is composed of contributed capital, while Bank B's equity is composed of both contributed capital and DTA. Furthermore, let the two banks have the same overall levels of the risky asset and equity. In other words, the following holds:

$$e_{A,t} = CC_{A,t} \qquad e_{B,t} = CC_{B,t} + DTA_{B,t}$$

$$e_{A,t} = e_{B,t} \qquad c_{A,t} = c_{B,t} \qquad y_{A,t} = y_{B,t}$$

$$DTA_{B,t} > 0 \quad \text{(i.e., } CC_{A,t} > CC_{B,t}\text{)}$$

When performance is good (i.e. when $\tilde{r}_{t+1} > 0$), the benefits from the DTA are realized in the form of tax savings. Those tax savings are then recognized in retained earnings. Thus, when performance is good, the equities of the two banks will be equal and the composition of equity is irrelevant. More importantly, when $\tilde{r}_{t+1} > 0$, equity is not needed to offset losses.

However, if performance is poor (i.e. when $\tilde{r}_{t+1} < 0$), equity is needed in order to offset the losses experienced by the bank's holding of the risky asset. For Bank A, it can suffer losses (negative realizations of $\tilde{r}_{t+1}$) without experiencing insolvency as long as the following condition holds:

$$\tilde{r}_{t+1} > -\frac{CC_{A,t}}{p_t y_t} \tag{9}$$

However, as soon as the future return becomes negative, Bank B's DTA become worthless (as they are only realizable in the state of the world where $\tilde{r}_{t+1} > 0$). Thus, Bank B can only suffer losses without becoming insolvent as long as the following condition holds:

$$\tilde{r}_{t+1} > -\frac{CC_{B,t}}{p_t y_t} \tag{10}$$

Since Bank A has a larger amount of contributed capital than Bank B (i.e. $CC_{A,t} > CC_{B,t}$), equation 9 will be satisfied for more random realizations of $\tilde{r}_{t+1}$ than will equation 10. Thus, the probability of insolvency will be higher for Bank B than Bank A. The increased insolvency probability is shown in Figure 2.

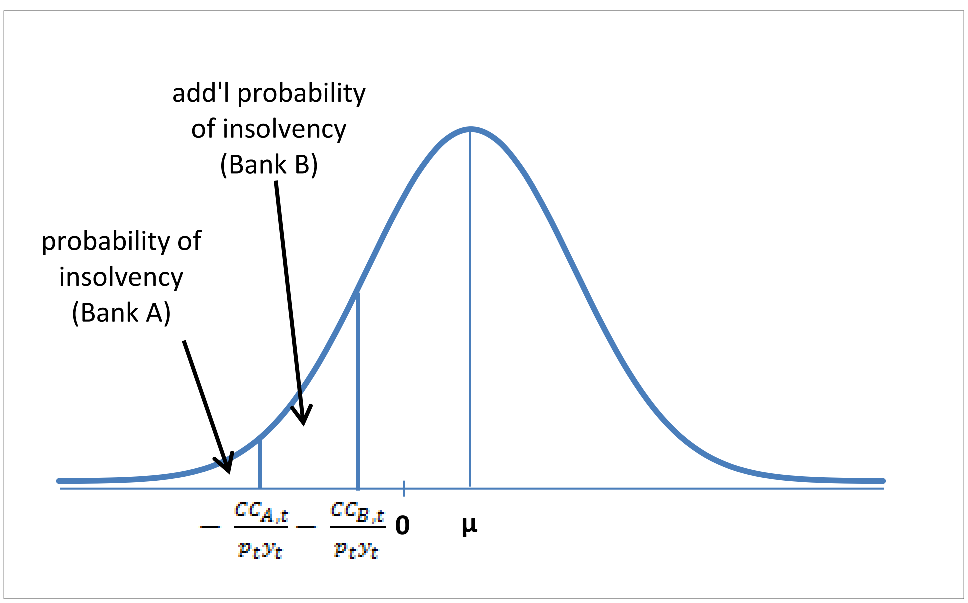

Figure 2: Insolvency probabilities during times of poor performance

To summarize the preceding discussion, when performance is poor, the actual equity of Bank B decreases relative to Bank A. Thus, the likelihood of insolvency will be higher for Bank B than Bank A. This forms the basis for Hypotheses 1 and 2a.

The credit risk associated with DTA capital is given by $Prob\left[-\frac{CC_{B-NoDTA,t}}{p_t y_t} < \tilde{r}_{t+1} \leq -\frac{CC_{B,t}}{p_t y_t}\right]$, where $CC_{B-NoDTA,t} = CC_{B,t} + DTA_{B,t}$ (replacing DTA capital with contributed capital). In other words, this is the additional probability of default that the bank incurs by holding a portion of its capital as DTA instead of contributed capital. In the above example, this is represented by the area under the probability curve between $-\frac{CC_{A,t}}{p_t y_t}$ and $-\frac{CC_{B,t}}{p_t y_t}$ in Figure 2 above (since Bank A is essentially Bank B with no DTA capital).

Now assume that there is a third bank, Bank C, that is similar in every way to Bank B (i.e., same amount of risky and risk-less asset holdings, composition of equity, and variance of future returns), except that the mean of the future return distribution is δ, where $\delta > \mu$. That is, Bank C is expected to be more profitable than Bank B. In this scenario, the return distribution for Bank C has been shifted to the right compared to that of Bank B. Because of the shift in the return distribution, Bank C has a smaller overall probably of insolvency than does Bank B. Furthermore, the additional credit risk associated with DTA is less for Bank C than Bank B, despite the fact that both banks have equivalent amounts of DTA capital. That is, $Prob\left[-\frac{CC_{C-NoDTA,t}}{p_t y_t} < \tilde{r}_{t+1} \leq -\frac{CC_{C,t}}{p_t y_t}\right]$ is smaller than $Prob\left[-\frac{CC_{B-NoDTA,t}}{p_t y_t} < \tilde{r}_{t+1} \leq -\frac{CC_{B,t}}{p_t y_t}\right]$. Figure 3 shows the insolvency probabilities for this scenario.

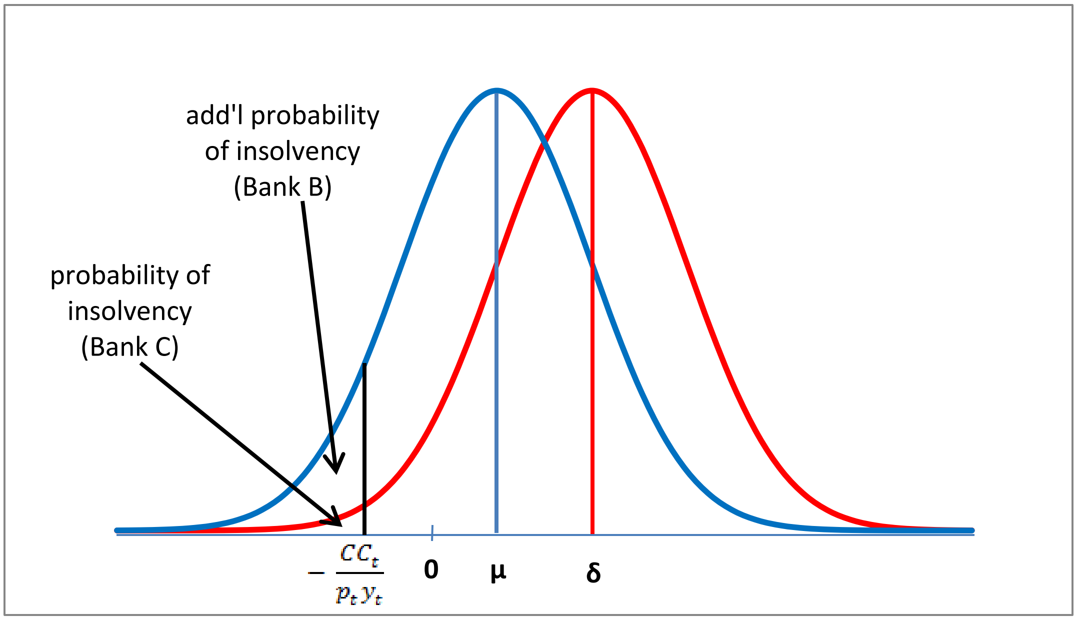

Figure 3: Insolvency probabilities when mean return is higher for one bank

Therefore, while there is still an additional probability of insolvency attached to the DTA component of equity, it is less so for the bank that ex-ante is expected to be more profitable. This forms the basis for Hypothesis 2b.

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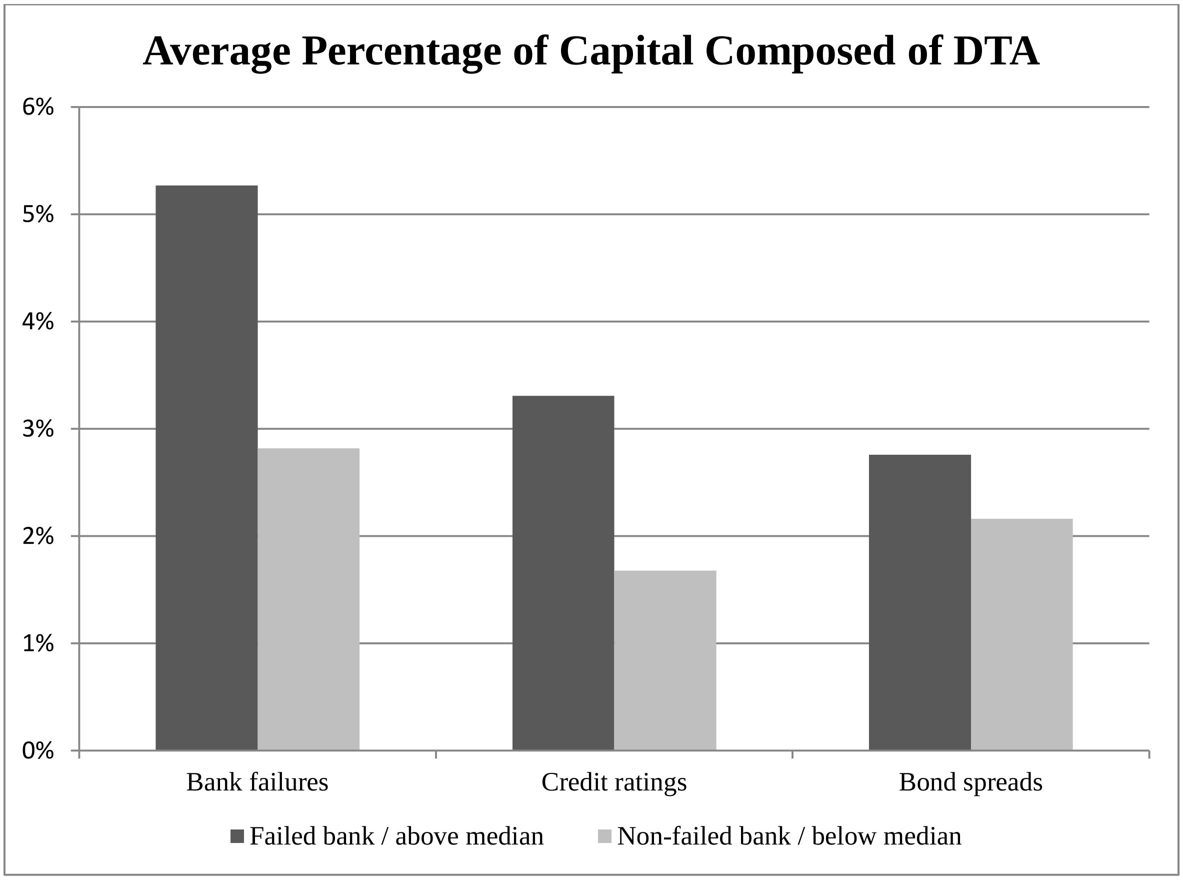
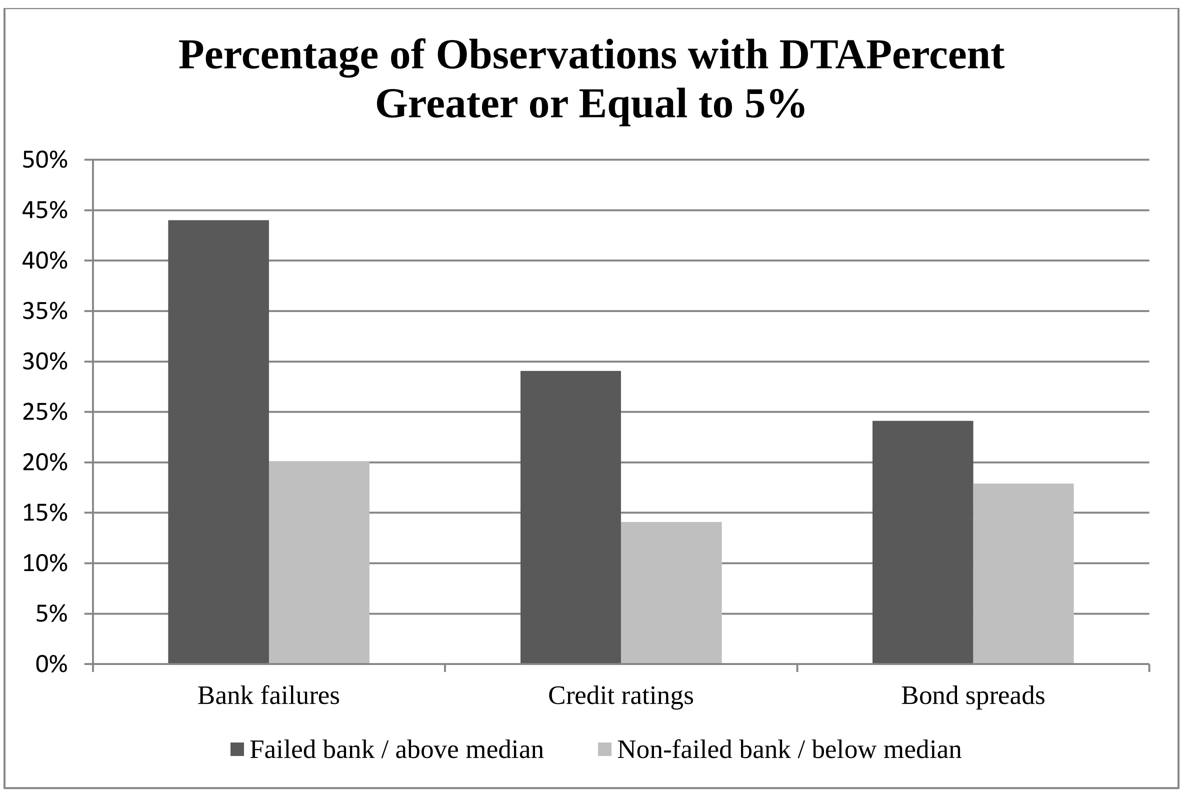
FIGURE 1



Average Percentage of Capital Composed of DTA
6%
5%
4%
3%
2%
1%
0%
Bank failures
Credit ratings
Bond spreads
Failed bank / above median
Non-failed bank / below median



Percentage of Observations with DTAPercent Greater or Equal to 5%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
Bank failures
Credit ratings
Bond spreads
Failed bank / above median
Non-failed bank / below median

TABLE 1 – DESCRIPTIVE STATISTICS AND CORRELATION MATRICES

Panel A – Descriptive Statistics for Commercial Bank Sample

Variable	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
DTAPercent	736	2.986	3.029	0.000	0.000	2.457	4.671	18.124
DTACapInd	736	0.740	0.439	0.000	0.000	1.000	1.000	1.000
Fail	736	0.068	0.252	0.000	0.000	0.000	0.000	1.000
Tier1Ratio	736	11.867	6.436	2.090	9.370	10.220	12.170	93.270
TotalRatio	736	13.212	6.395	3.400	10.690	11.415	13.450	93.460
LeverageRatio	736	9.320	4.853	1.700	7.620	8.520	9.610	96.420
RealEstateLoans	736	50.934	18.961	0.000	41.141	53.988	63.647	87.243
Nonperform	736	0.963	1.191	0.000	0.276	0.608	1.161	7.225
AssetRisk	736	77.102	11.799	33.616	72.402	79.367	84.756	96.988
Overhead	736	2.701	1.266	0.239	2.130	2.546	3.066	9.629
ROA4Qtr	736	0.026	0.019	-0.018	0.017	0.025	0.032	0.130
DepositLiquidity	736	5.146	8.158	0.339	2.400	3.410	4.665	61.014
Size	736	7.737	1.194	6.636	6.878	7.323	8.135	12.073
West	736	0.204	0.403	0.000	0.000	0.000	0.000	1.000

Panel B – Descriptive Statistics for Bank Holding Company Sample

Variable	N	Mean	Std Dev	Minimum	25th Pctl	Median	75th Pctl	Maximum
DTAPercent	2049	2.414	3.409	0.000	0.000	0.168	4.286	16.135
DTACapInd	2049	0.547	0.498	0.000	0.000	1.000	1.000	1.000
Δ*DTAIncluded*	1744	0.011	0.089	-0.253	0.000	0.000	0.015	0.426
$Rating_{t+1}$	2049	7.345	2.277	2.000	6.000	7.000	9.000	22.000
$Spread_{t+1}$	1030	222.132	207.919	48.151	99.812	139.037	243.800	1048.990
Tier1Ratio	2049	11.734	10.444	6.430	8.550	9.900	11.660	107.770
TotalRatio	2049	14.447	10.010	10.040	11.680	12.550	14.130	107.880
LeverageRatio	2049	8.868	6.917	4.130	6.920	7.810	8.840	76.260
Size	2049	10.420	1.376	8.574	9.305	10.156	11.226	14.390
ROAQtr	2049	0.300	0.358	-1.130	0.226	0.312	0.383	2.349
ROA4Qtr	2049	1.249	1.393	-3.896	0.921	1.263	1.544	9.760
Liquid	2049	23.332	12.004	1.757	14.987	20.657	28.887	64.569
Loans	2049	57.049	17.678	4.559	51.008	63.238	68.843	79.484
Volatility	2049	0.079	0.030	0.035	0.056	0.077	0.094	0.186
Maturity	1002	13.243	7.343	2.197	7.489	10.673	19.236	29.078
Coupon	1002	626.244	102.692	318.771	567.300	637.500	679.789	937.500
Crisis	2049	0.161	0.367	0.000	0.000	0.000	0.000	1.000

Panel C – Correlation Matrix for Commercial Bank Sample

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	*DTAPercent*		0.58	0.20	-0.13	-0.12	-0.10	0.13	0.18	0.08	0.03	-0.16	-0.06	-0.04	0.10
2	*DTACapInd*	0.77		0.12	-0.11	-0.13	-0.09	0.17	0.03	0.10	-0.03	-0.15	-0.09	-0.16	0.05
3	*Fail*	0.18	0.12		-0.08	-0.08	-0.02	0.22	0.29	0.15	-0.04	-0.01	-0.08	-0.04	0.19
4	*Tier1Ratio*	-0.13	-0.07	-0.12		0.99	0.73	-0.28	-0.03	-0.28	0.01	0.22	0.23	-0.08	0.03
5	*TotalRatio*	-0.11	-0.11	-0.14	0.88		0.73	-0.30	-0.03	-0.29	0.03	0.23	0.25	-0.03	0.04
6	*LeverageRatio*	-0.03	0.00	0.00	0.59	0.51		-0.19	0.01	0.04	0.12	0.42	0.26	-0.08	0.14
7	*RealEstateLoans*	0.18	0.18	0.24	-0.17	-0.25	0.09		0.20	0.25	-0.20	-0.20	-0.31	-0.34	0.02
8	*Nonperform*	0.11	0.06	0.20	-0.19	-0.16	-0.05	0.20		0.17	0.02	-0.13	-0.11	-0.06	0.03
9	*AssetRisk*	0.07	0.08	0.17	-0.20	-0.28	0.20	0.24	0.22		0.12	0.15	-0.17	-0.30	0.14
10	*Overhead*	0.01	-0.02	-0.07	-0.08	-0.04	0.00	-0.08	0.07	0.11		0.21	0.11	0.02	0.00
11	*ROA4Qtr*	-0.15	-0.12	-0.03	0.04	0.05	0.24	-0.09	-0.13	0.21	0.08		0.13	0.02	0.20
12	*DepositLiquidity*	-0.15	-0.13	-0.18	0.05	0.11	-0.02	-0.36	-0.10	-0.03	0.33	0.20		0.21	0.04
13	*Size*	-0.01	-0.07	0.00	-0.21	-0.07	-0.18	-0.28	-0.01	-0.22	-0.09	0.02	0.10		0.03
14	*West*	0.09	0.05	0.19	-0.01	0.03	0.17	0.06	0.02	0.16	-0.02	0.21	-0.03	0.08	

Panel D – Correlation Matrix for Bank Holding Company Sample

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	*DTAPercent*		0.64	0.27	0.45	-0.02	-0.03	-0.02	-0.12	-0.16	-0.18	-0.08	0.09	0.06	-0.34	-0.08	0.21
2	*DTACapInd*	0.91		0.35	0.28	0.03	0.01	0.01	-0.23	-0.10	-0.11	-0.01	0.05	0.03	-0.38	-0.11	0.09
3	$Rating_{t+1}$	0.38	0.37		0.34	-0.05	-0.08	-0.07	-0.59	-0.24	-0.28	-0.15	0.05	0.36	-0.42	-0.02	0.01
4	$Spread_{t+1}$	0.31	0.19	0.27		0.24	0.24	0.33	0.00	-0.58	-0.65	-0.16	0.13	0.28	-0.21	0.06	0.57
5	*Tier1Ratio*	0.22	0.22	0.33	0.19		0.99	0.97	-0.21	0.64	0.71	0.33	-0.47	0.11	-0.28	-0.11	0.01
6	*TotalRatio*	0.14	0.13	0.12	0.13	0.80		0.97	-0.17	0.64	0.71	0.31	-0.45	0.10	-0.22	-0.15	0.02
7	*LeverageRatio*	0.15	0.13	0.23	0.24	0.60	0.56		-0.19	0.64	0.72	0.23	-0.34	0.05	-0.31	-0.18	0.05
8	*Size*	-0.25	-0.26	-0.62	0.03	-0.44	-0.20	-0.31		-0.11	-0.11	-0.22	-0.10	0.04	0.54	0.18	0.05
9	*ROAQtr*	-0.19	-0.14	-0.24	-0.52	-0.03	0.00	0.01	-0.03		0.90	0.24	-0.33	-0.12	0.16	0.02	-0.26
10	*ROA4Qtr*	-0.21	-0.14	-0.27	-0.52	-0.07	-0.04	0.01	0.00	0.89		0.24	-0.34	-0.18	0.19	0.02	-0.22
11	*Liquid*	0.02	0.07	-0.01	-0.23	0.44	0.40	0.08	-0.29	0.16	0.14		-0.56	0.02	-0.09	-0.10	-0.09
12	*Loans*	0.06	0.03	0.14	0.11	-0.37	-0.36	0.14	-0.05	-0.09	-0.07	-0.55		-0.36	-0.13	0.03	0.11
13	*Volatility*	-0.02	-0.03	0.15	0.19	0.23	0.29	0.03	0.06	-0.08	-0.16	0.04	-0.30		0.03	0.03	-0.06
14	*Maturity*	-0.43	-0.40	-0.46	-0.05	-0.33	-0.20	-0.36	0.60	0.23	0.23	-0.07	-0.20	0.12		0.43	-0.25
15	*Coupon*	-0.13	-0.13	-0.11	0.25	-0.09	-0.10	-0.21	0.23	0.00	-0.01	-0.01	-0.10	0.12	0.47		-0.09
16	*Crisis*	0.15	0.09	0.02	0.54	0.01	0.01	0.12	0.05	-0.38	-0.37	-0.13	0.14	-0.09	-0.28	-0.10	

This table contains the descriptive statistics and correlation matrices for both the commercial bank sample and bank holding company sample. Panel A (B) contains the descriptive statistics and Panel C (D) contains the correlation matrix for the commercial bank (bank holding company) sample. Spearman (Pearson) correlations are above (below) the diagonal. *DTAPercent* is the amount of DTA included in tier 1 capital divided by tier 1 capital. *DTACapInd* is an indicator variable equal to one if *DTAPercent* is positive, and zero otherwise. *Fail* is an indicator variable equal to one if the bank failed between January 1, 2008 and June 30, 2010, and zero otherwise. *Tier1Ratio* is the bank's tier 1 capital ratio. *TotalRatio* is the bank's total capital ratio. *LeverageRatio* is the bank's leverage ratio. *RealEstateLoans* is the ratio of the bank's real estate loans to total assets. *Nonperform* is the ratio of non-performing loans to total loans. *AssetRisk* is the ratio of the bank's 100 percent risk-weighted assets to total risk-weighted assets. *Overhead* is the non-interest expense as a percentage of total assets. *ROA4Qtr* is the net income over the past four quarters, scaled by average total assets over the same period. *DepositLiquidity* is the bank's cash and available-for-sale securities as a percentage of total deposits. *Size* is the natural logarithm of total assets. *West* is an indicator variable equal to one of the bank was located in the Region 4 according to the U.S. Census Bureau, and zero otherwise. *ΔDTAIncluded* is the current quarter's DTA included in regulatory capital minus the previous quarter's DTA included in capital, scaled by lagged total assets. $Rating_{t+1}$ is the bank's Standard & Poor credit rating for quarter t+1, where 1 represents the highest rating (AAA) and 22 represents the lowest rating (SD or D). $Spread_{t+1}$ is the difference in the yield from the bank's outstanding bonds and a risk-free security of equivalent duration. *Size* is the natural logarithm of total assets. *ROAQtr* is net income in quarter t scaled by total assets. *Liquidity* is the sum of cash and available-for-sale securities scaled by total assets. *Loans* is total loans outstanding scaled by total assets. *Volatility* is the standard deviation of monthly returns over the prior 60 months. *Maturity* is the time remaining to maturity (measured in years). *Coupon* is the bond's annual coupon rate. *Crisis* is an indicator variable equal to one if the bank-quarter occurs during the recent recession as defined by the NBER (December 2007 through June 2009), and zero otherwise. All variables are measured at quarter t except for Spread and Rating (measured at quarter t+1) and Fail (measured between January 1, 2008 and June 30, 2010). All continuous variables except *DTAPercent* and capital ratios are winsorized at the 1% and 99% level. Ratios are measured in percentages. Note that descriptive statistics for *ΔDTAIncluded* were only calculated using those firms that were included in the analysis in Table 6.

TABLE 2 – ASSOCIATION BETWEEN DTA CAPITAL AND BANK FAILURES

Panel A – Coefficients

VARIABLES	*Pred. Sign*	(1) *h(t)*	(2) *h(t)*	(3) *h(t)*	(4) *h(t)*	(5) *h(t)*
DTAPercent	+		0.201***	0.102***	0.110***	0.107***
			(5.642)	(2.882)	(3.363)	(2.971)
Tier1Ratio	?	-0.174*		-0.154*		
		(-1.934)		(-1.751)		
TotalRatio	?				-0.197*	
					(-1.740)	
LeverageRatio	?					-0.126
						(-1.156)
RealEstateLoans	+	0.054***		0.054***	0.054***	0.057***
		(4.313)		(4.125)	(4.096)	(4.456)
Nonperform	+	0.477***		0.440***	0.448***	0.417***
		(6.760)		(5.872)	(6.012)	(5.464)
AssetRisk	+	0.042*		0.037	0.036	0.045*
		(1.774)		(1.534)	(1.492)	(1.770)
Overhead	?	-0.178		-0.129	-0.128	-0.106
		(-0.842)		(-0.599)	(-0.588)	(-0.512)
ROA4Qtr	-	-5.305		-1.298	0.270	-1.056
		(-0.388)		(-0.090)	(0.019)	(-0.077)
DepositLiquidity	-	-0.051		-0.042	-0.035	-0.049
		(-0.469)		(-0.375)	(-0.325)	(-0.536)
Size	?	0.113		0.113	0.150	0.157
		(0.666)		(0.639)	(0.842)	(0.877)
West	+	1.343***		1.314***	1.317***	1.374***
		(4.217)		(3.915)	(3.915)	(4.034)
Observations		736	736	736	736	736

Panel B – Hazard ratios

VARIABLES	*Prediction*	(1)	(2)	(3)	(4)	(5)
DTAPercent	> 1		1.838	1.362	1.395	1.383
Tier1Ratio	?	0.326		0.371		
TotalRatio	?				0.284	
LeverageRatio	?					0.543
RealEstateLoans	> 1	2.784		2.784	2.784	2.947
Nonperform	> 1	1.765		1.689	1.705	1.643
AssetRisk	> 1	1.641		1.547	1.529	1.701
Overhead	?	0.798		0.849	0.850	0.874
ROA4Qtr	< 1	0.902		0.975	1.005	0.980
DepositLiquidity	< 1	0.660		0.710	0.752	0.670
Size	?	1.144		1.144	1.196	1.206
West	> 1	3.831		3.721	3.732	3.951

This table contains the results of estimating the association between failure risk and the proportion of tier 1capital composed of DTA (equation 1) using a Cox proportional hazards model on the commercial bank sample. *DTAPercent* is the amount of DTA included in tier 1 capital divided by tier 1 capital. *Tier1Ratio* is the bank's tier 1 capital ratio. *TotalRatio* is the bank's total capital ratio. *LeverageRatio* is the bank's leverage ratio. *RealEstateLoans* is the ratio of the bank's real estate loans to total assets. *Nonperform* is the ratio of non-performing loans to total loans. *AssetRisk* is the ratio of the bank's 100 percent risk-weighted assets to total risk-weighted assets. *Overhead* is the non-interest expense as a percentage of total assets. *ROA4Qtr* is the net income over the past four quarters, scaled by average total assets over the same period. *DepositLiquidity* is the bank's cash and available-for-sale securities as a percentage of total deposits. *Size* is the natural logarithm of total assets. *West* is an indicator variable equal to one of the bank was located in the Region 4 according to the U.S. Census Bureau, and zero otherwise. The independent variable of interest is *DTAPercent*. Coefficients are reported in Panel A, hazard ratios are reported in Panel B. Hazard ratios are calculated using a one-standard deviation change for continuous variables and a one-unit change for indicator variables. Z-statistics reported in parentheses are based on standard errors clustered by bank. *, **, *** represent two-tailed p-values less than 0.10, 0.05, and 0.01, respectively.

TABLE 3 – ASSOCIATION BETWEEN DTA CAPITAL AND CREDIT RATINGS

VARIABLES	Pred. Sign.	(1) $Rating_{t+1}$	(2) $Rating_{t+1}$	(3) $Rating_{t+1}$	(4) $Rating_{t+1}$	(5) $Rating_{t+1}$	(6) $Rating_{t+1}$
DTAPercent	+		0.167***	0.131***	0.123***	0.132***	0.132***
			(3.824)	(3.185)	(2.966)	(3.197)	(3.209)
Tier1Ratio	?	-0.017		-0.020	0.003		
		(-1.026)		(-1.290)	(0.152)		
TotalRatio	?					-0.023	
						(-1.586)	
LeverageRatio	?						-0.039*
							(-1.929)
Size	-	-1.828***		-1.827***	-1.848***	-1.822***	-1.835***
		(-8.656)		(-8.392)	(-8.157)	(-8.474)	(-8.250)
ROAQtr	-	-1.970***		-1.873***		-1.823***	-1.724***
		(-3.714)		(-3.640)		(-3.644)	(-3.865)
ROA4Qtr	-				-0.684***		
					(-3.725)		
Liquidity	-	-0.081***		-0.083***	-0.088***	-0.082***	-0.083***
		(-3.886)		(-4.041)	(-3.984)	(-4.025)	(-4.047)
Loans	-	-0.020		-0.021	-0.025	-0.021	-0.020
		(-1.297)		(-1.403)	(-1.551)	(-1.397)	(-1.348)
Volatility	+	30.990***		29.995***	26.364***	30.186***	30.418***
		(4.755)		(4.583)	(3.748)	(4.596)	(4.529)
Crisis	+	-0.180		-0.398*	-0.455**	-0.383*	-0.338
		(-0.930)		(-1.915)	(-2.074)	(-1.847)	(-1.596)
Observations		2,049	2,049	2,049	2,049	2,049	2,049
Pseudo R-squared		0.238	0.022	0.251	0.257	0.251	0.251

This table contains the results of estimating the association between credit ratings and the proportion of tier 1 capital composed of DTA (equation 2) using ordered logistic regression on the bank holding company sample. $Rating_{t+1}$ is the bank's Standard & Poor credit rating for quarter t+1, where 1 represents the highest rating (AAA) and 22 represents the lowest rating (SD or D). *DTAPercent* is the amount of DTA included in tier 1 capital divided by tier 1 capital. *Tier1Ratio* is the bank's tier 1 capital ratio. *TotalRatio* is the bank's total capital ratio. *LeverageRatio* is the bank's leverage ratio. *Size* is the natural logarithm of total assets. *ROAQtr* is net income in quarter t scaled by total assets. *ROA4Qtr* is the sum of net income over the previous four quarters over the average total assets during the same period. *Liquidity* is the sum of cash and available-for-sale securities scaled by total assets. *Loans* is total loans outstanding scaled by total assets. *Volatility* is the standard deviation of monthly returns over the prior 60 months. *Crisis* is an indicator variable equal to one if the bank-quarter occurs during the recent recession as defined by the NBER (December 2007 through June 2009), and zero otherwise. The dependent variable is the S&P credit rating (*Rating*). The independent variable of interest is *DTAPercent*. The dependent variable is measured in quarter t+1, and all independent variables are measured in quarter t. Z-statistics reported in parentheses are based on standard errors clustered by bank. *, **, *** represent two-tailed p-values less than 0.10, 0.05, and 0.01, respectively.

TABLE 4 – ASSOCIATION BETWEEN DTA CAPITAL AND BOND SPREADS

VARIABLES	Pred. Sign.	(1) $Spread_{t+1}$	(2) $Spread_{t+1}$	(3) $Spread_{t+1}$	(4) $Spread_{t+1}$	(5) $Spread_{t+1}$	(6) $Spread_{t+1}$
DTAPercent	+		25.686***	7.920*	6.592	8.277**	8.690**
			(5.539)	(1.989)	(1.677)	(2.082)	(2.168)
Tier1Ratio	?	22.725***		19.657**	19.190***		
		(2.752)		(2.630)	(2.975)		
TotalRatio	?					22.017***	
						(3.247)	
LeverageRatio	?						26.749***
							(2.958)
Size	-	21.020		20.092*	18.276	14.746	12.550
		(1.636)		(1.700)	(1.593)	(1.344)	(1.167)
ROAQtr	-	-242.594***		-225.127***		-230.205***	-236.523***
		(-5.988)		(-5.669)		(-5.873)	(-5.992)
ROA4Qtr	-				-85.131***		
					(-7.814)		
Liquidity	-	-1.642*		-1.214	-1.288	-1.737	-1.056
		(-1.720)		(-1.198)	(-1.084)	(-1.670)	(-1.021)
Loans	-	1.493*		1.416*	0.941	0.743	-0.422
		(1.840)		(1.735)	(1.131)	(0.895)	(-0.612)
Volatility	+	1,380.074***		1,350.389***	705.318*	1,259.886**	1,365.637***
		(3.000)		(2.876)	(1.687)	(2.534)	(3.108)
Maturity	?	-3.818**		-2.773	-2.210	-2.791	-2.409
		(-2.162)		(-1.555)	(-1.256)	(-1.670)	(-1.387)
Coupon	+	0.283***		0.268**	0.255**	0.298***	0.317***
		(2.843)		(2.626)	(2.522)	(3.246)	(3.374)
Crisis	+	211.745***		198.274***	189.109***	200.305***	191.909***
		(10.991)		(10.156)	(9.770)	(10.249)	(9.940)
Constant		-497.312**	158.508***	-485.139**	-344.080*	-483.529**	-348.762*
		(-2.263)	(13.904)	(-2.331)	(-1.806)	(-2.420)	(-1.896)
Observations		1,002	1,030	1,002	1,002	1,002	1,002
Adjusted R-squared		0.578	0.199	0.591	0.626	0.597	0.598

This table contains the results of estimating the association between bond spreads and the proportion of tier 1 capital composed of DTA (equation 3) using OLS on the bank holding company sample. $Spread_{t+1}$ is the difference in the yield from the bank's outstanding bonds and a risk-free security of equivalent duration. *DTAPercent* is the amount of DTA included in tier 1 capital divided by tier 1 capital. *Tier1Ratio* is the bank's tier 1 capital ratio. *TotalRatio* is the bank's total capital ratio. *LeverageRatio* is the bank's leverage ratio. *Size* is the natural logarithm of total assets. *ROAQtr* is net income in quarter t scaled by total assets. *ROA4Qtr* is the sum of net income over the previous four quarters over the average total assets during the same period. *Liquidity* is the sum of cash and available-for-sale securities scaled by total assets. *Loans* is total loans outstanding scaled by total assets. *Volatility* is the standard deviation of monthly returns over the prior 60 months. *Maturity* is the time remaining to maturity (measured in years). *Coupon* is the bond's annual coupon rate. *Crisis* is an indicator variable equal to one if the bank-quarter occurs during the recent recession as defined by the NBER (December 2007 through June 2009), and zero otherwise. The dependent variable is the bond spread (*Spread*). The independent variable of interest is *DTAPercent*. The dependent variable is measured in quarter t+1, and all independent variables are measured in quarter t. t-statistics reported in parentheses are based on standard errors clustered by bank. *, **, *** represent two-tailed p-values less than 0.10, 0.05, and 0.01, respectively.

TABLE 5 – ASSOCIATION BETWEEN DTA CAPITAL, CREDIT RISK, AND PROFITABILITY

	Pred.	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	*Sign.*	*Rating$_{t+1}$*	*Rating$_{t+1}$*	*Rating$_{t+1}$*	*Rating$_{t+1}$*	*Spread$_{t+1}$*	*Spread$_{t+1}$*
DTAPercent	+	0.138***	0.092*	0.149***	0.074*	17.098***	10.038**
		(3.242)	(1.844)	(3.288)	(1.870)	(4.203)	(2.402)
*DTAPercent*ROA4Qtr*	-	0.015	0.035	0.008	0.010	-4.899**	-5.563**
		(0.795)	(1.360)	(0.351)	(0.534)	(-2.158)	(-2.612)
ROA4Qtr	-	-0.337***	-0.787***	-0.407***	-0.493***	-105.848***	-64.501***
		(-2.921)	(-3.423)	(-3.052)	(-3.091)	(-6.425)	(-4.791)
Tier1Ratio	?		0.009		-0.004		19.312***
			(0.434)		(-0.183)		(3.154)
Size	-		-1.842***		-1.201***		15.849
			(-8.126)		(-9.927)		(1.490)
Liquidity	-		-0.088***		-0.070***		-1.565
			(-3.996)		(-3.755)		(-1.562)
Loans	-		-0.024		-0.033**		0.759
			(-1.514)		(-2.224)		(1.091)
Volatility	+		26.859***		19.309***		542.694
			(3.799)		(3.835)		(1.324)
Maturity	?						
Coupon	+						
Crisis	+		-0.437**		-0.220		192.428***
			(-2.006)		(-1.216)		(9.735)
Constant				7.261***	26.615***	295.418***	-320.900*
				(22.576)	(4.087)	(13.613)	(-1.827)
Observations		2,049	2,049	2,049	2,049	1,030	1,002
Adj./Pseudo R-squared		0.0349	0.2578	0.131	0.675	0.482	0.633

This table contains the results of estimating the association between credit ratings and bond spreads and the proportion of tier 1 capital composed of DTA, conditional on expected profitability (equations 4 and 5) using ordered logistic regression (models 1 and 2) and OLS (models 3, 4, 5, and 6) on the bank holding company sample. *Rating$_{t+1}$* is the bank's Standard & Poor credit rating for quarter t+1, where 1 represents the highest rating (AAA) and 22 represents the lowest rating (SD or D). *Spread$_{t+1}$* is the difference in the yield from the bank's outstanding bonds and a risk-free security of equivalent duration. *DTAPercent* is the amount of DTA included in tier 1 capital divided by tier 1 capital. *Tier1Ratio* is the bank's tier 1 capital ratio. *Size* is the natural logarithm of total assets. *ROA4Qtr* is the sum of net income over the previous four quarters over the average total assets during the same period. *Liquidity* is the sum of cash and available-for-sale securities scaled by total assets. *Loans* is total loans outstanding scaled by total assets. *Volatility* is the standard deviation of monthly returns over the prior 60 months. *Maturity* is the time remaining to maturity (measured in years). *Coupon* is the bond's annual coupon rate. *Crisis* is an indicator variable equal to one if the bank-quarter occurs during the recent recession as defined by the NBER (December 2007 through June 2009), and zero otherwise. The dependent variable in models 1 through 4 is *Rating*, and the dependent variable in models 5 and 6 is *Spread*. The independent variable of interest is the interaction of *DTAPercent* and *ROA4Qtr*. The dependent variable is measured in quarter t+1, and all independent variables are measured in quarter t. t-statistics for OLS regressions (Z-statistics for ordered logistic regressions) reported in parentheses are based on standard errors clustered by bank. *, **, *** represent two-tailed p-values less than 0.10, 0.05, and 0.01, respectively.

TABLE 6 – ASSOCIATION BETWEEN CHANGES IN DTA INCLUDED IN CAPITAL AND FUTURE RISK OUTCOMES

PANEL A – CHANGE IN FUTURE EQUITY VOLATILITY

VARIABLES	*Pred. Sign.*	(1) *ΔVolatility Next Qtr*	(2) *ΔVolatility Next 2 Qtr*	(3) *ΔVolatility Next Year*
ΔDTAIncluded	?	-0.001	-0.001	-0.007*
		(-0.328)	(-0.347)	(-1.753)
PoorlyCapitalized	?	0.000	0.001	0.001
		(1.426)	(1.405)	(1.146)
*ΔDTAIncluded*PoorlyCapitalized*	+	0.011***	0.018***	0.029***
		(3.367)	(2.937)	(3.560)
*ΔDTAIncluded + ΔDTAIncluded*PoorlyCapitalized*		0.010***	0.017***	0.022***
Controls Included?		YES	YES	YES
Observations		1,744	1,744	1,744
Adjusted R-squared		0.375	0.457	0.453

PANEL B – CHANGE IN FUTURE NONPERFORMING LOANS

VARIABLES	*Pred. Sign.*	(1) *ΔNPL Next Qtr*	(2) *ΔNPL Next 2 Qtr*	(3) *ΔNPL Next Year*
ΔDTAIncluded	?	-0.001	-0.003	-0.002
		(-0.773)	(-1.372)	(-1.060)
PoorlyCapitalized	?	-0.000	0.000	0.000
		(-0.463)	(0.082)	(0.028)
*ΔDTAIncluded*PoorlyCapitalized*	+	0.002	0.008**	0.012**
		(1.145)	(2.218)	(2.282)
*ΔDTAIncluded + ΔDTAIncluded*PoorlyCapitalized*		0.001	0.005*	0.010**
Controls Included?		YES	YES	YES
Observations		1,744	1,744	1,744
Adjusted R-squared		0.187	0.270	0.298

This table contains the results of estimating the association between future change in risk and the current change in the amount of DTA capital included in tier 1 capital (equation 6) using OLS on the bank holding company sample. The dependent variable in Panel A is $\Delta Volatility_{t+j}$, which is defined as *Volatility* in quarter t+j minus *Volatility* in quarter t. The dependent variable in Panel B is ΔNPL_{t+j}, which is defined as non-performing loans in quarter t+j minus non-performing loans in quarter t, scaled by total loans in quarter t. Dependent variables are measured over three different time periods: the next quarter, the next two quarters, and the next four quarters. The independent variable of interest is the interaction of *ΔDTAIncluded* (the DTA included in tier 1 capital in the current quarter minus the DTA included in tier 1 capital in the previous quarter, scaled by total assets in the previous quarter) and *PoorlyCapitalized* (indicator variable equal to 1 if the bank has a tier 1 ratio in the bottom 30 percent of all banks at the beginning of the quarter and zero otherwise). For brevity, only the coefficients on the *ΔDTAIncluded*, *PoorlyCapitalized*, and the interaction term are reported. t-statistics are based on standard errors clustered by bank. *, **, *** represent two-tailed p-values less than 0.10, 0.05, and 0.01, respectively.